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Addendum to TUPOS
Incorporation of a
Hesitant Plume Algorithm

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ADDENDUM TO TUPOS - INCORPORATION OF A HESITANT PLUME ALGORITHM

by

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The existance of non-Gaussian plume behavior within the convective boundary layer has been pointed out and recently discussed at a national conference. Briggs has suggested convective scaling parameterizations for surface crosswind integrated concentrations. Combined with parameterization of the crosswind spreading and assuming that the horizontal diffusion is Gaussian, allows estimation of concentrations on the horizontal plane. These techniques have been incorporated into an existing dispersion computer code to result in TUPOS-2.0.

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ABSTRACT

The existence of non-Gaussian plume behavior within the convective boundary layer has been pointed out and recently discussed at a national conference. Briggs has suggested convective scaling parameterizations for surface crosswind integrated concentrations. By parameterizing the crosswind spreading and assuming that the horizontal diffusion is Gaussian, concentrations can be estimated on the horizontal plane. These techniques have been incorporated into an existing dispersion computer code to result in TUPOS-2.0.

HESITANT PLUME ALGORITHM

This addendum makes changes to the TUPOS model (Turner et al., 1986) in order to better account for buoyant plumes that bump against but do not penetrate the inversion layer at the mixing height. The resulting algorithm is TUPOS-2.0. Briggs (1985) reports that this plume behavior was discussed at the AMS/EPA Workshop on Updating Applied Diffusion Models in January 1984. In such cases the buoyant forces within the plume, although unable to penetrate the inversion, both resist downward motion and result in increased horizontal spreading.

Because of its hesitancy for downward dispersion, the author is using "hesitant plume" to refer to the above plume behavior.

Briggs (1985) and in a discussion (Briggs, 1986) made several suggestions as to possible calculation methods to treat the hesitant plume. The suggestions are based upon analysis of limited available data. This therefore represents a provisional modeling framework that is quite likely to be modified as its calculations are compared to additional data sets.

A paper to be presented later this year (Pierce, 1986) examines additional data in relation to the hesitant plume.

Under convective conditions, strongly buoyant sources have displayed vertical diffusion effects mentioned above that are quite non-Gaussian. From his analysis of data for the Dickerson and Morgantown power plants (Weil, 1977), Briggs (1985) recommends that a parameterization of the ground-level crosswind integrated concentration be employed. This parameterization is expressed by equation (23) of Briggs (1985):

$$C_y = \exp\left[-(7\ F^*/\ X)^{3/2}\right] \qquad (1)$$

where C_y is a dimensionless parameter related to the crosswind integrated concentration:

$$C_y = z_i \; U \int \chi \, dy / \; Q \tag{2}$$

where z_i is mixing height, U is wind speed, and Q is emission rate.

The definitions of F* and X are:

$$F^* = F_b \; / \; (U \; w^{*2} \; z_i) \tag{3}$$

where F_b is the buoyancy flux of the source, and

$$X \; = (x/U) \; w^* / \; z_i) \tag{4}$$

Note that in considering the ratio $F^*/X = F_b/(xw^{*3})$, both U and z_i cancel.

If one assumes that the crosswind distribution can be represented by the Gaussian distribution, then the relation between the crosswind integrated concentration and the centerline ground level concentration is:

$$\chi CL = \int \chi \, dy / (\sqrt{2\pi} \; \sigma_y) \tag{5}$$

Rewriting the definition of C_y (eq.2):

$$\int \chi \, dy = Q \; C_y / (z_i \; U) \tag{6}$$

Substituting (6) into (5) yields

$$\chi CL = Q \; C_y \; / \; (2.507 \; \sigma_y \; z_i \; U) \tag{7}$$

Substituting (1) into (7) including the definition of F* and X and considering the relation of off-axis concentrations to centerline concentrations, the concentration at a point x,y in the ground-level plane becomes:

$$\chi \, (x,y,0) = Q' \; \exp\{ -[7F_b/(x \; w^{*3})]^{3/2} \} \; \exp[-0.5(y/\sigma_y)^2]/(2.507 \; U \; z_i \; \sigma_y) \tag{8}$$

where Q' is the emission rate due to that portion of the plume beneath z_i.

The spreading of the hesitant plume is a function of buoyancy. Using equation (24) of Briggs (1985):

$$\sigma_y/z_i = 1.6\ F^{*1/3}\ X^{2/3} \tag{9}$$

Substituting for the definitions of F* and X yields:

$$\sigma_y = 1.6\ F_b^{1/3}\ x^{2/3}/U \tag{10}$$

If eq. 10 yields $\sigma_y > 0.8\ x$, σ_y is set equal to 0.8 x.

Note that in substituting eq. (10) for σ_y in eq. (8), the hesitant plume concentration beneath the centerline becomes independent of wind speed.

In order to evaluate eq. (8) it is necessary to estimate the convective scaling velocity, w*.

$$w^* = (H^*\ z_i)^{1/3} \tag{11}$$

Although the convective scaling parameter, H*, can be found using the density fluctuation flux:

$$H^* = (g/\overline{T_v})\ \overline{w'T_v'} \tag{12}$$

where T_v is absolute virtual temperature. The convective sealing parameter can be found from the surface sensible heat flux, H, from

$$H^* = g\ H/(c_p\ \rho_a\ T_a) \tag{13}$$

where latent heat effects are ignored. If H is in watts m^{-2}, H* ($m^2\ s^{-3}$) can be found by substituting numerical values for g and c_p and using the gas law relations for density to result in:

$$H^* = 2.80 \times 10^{-2}\ H/p \tag{14}$$

where p is atmospheric pressure in mb. The constant has units of m^4 mb $watt^{-1}$ s^{-3}.

Examination of the solutions of equations (8) and (10) for several values of z_i as F_b increases compared with the ground level concentrations from the Gaussian model of TUPOS for neutral-unstable conditions indicate a smooth transition between the two techniques at $F^* = 0.09$, very close to the F^* of 0.1 mentioned by Briggs. Therefore the principal criterion to use the hesitant plume calculations is for F^* to equal or exceed 0.09.

A slight revision of MPDA (Paumier et al., 1986) places both the surface sensible heat flux, H, and atmospheric pressure, p, on the output file for availability to TUPOS-2.0.

In this revision to TUPOS if a value for the atmospheric pressure is missing, a pressure of 990 is used. In addition to the criterion $F^* > 0.09$ mentioned above, two additional criteria are used: $H^* > 0.001$ and $w^* > 0$. This eliminates both low or negative heat flux and missing data which are labeled as -9999.

It may become necessary to incorporate an additional criterion to eliminate high wind speed cases, such as $U/w^* > 6$; no such criterion is currently incorporated. Requiring that F^* exceed 0.09 tends to eliminate high wind speed cases.

Calculations made using the hesitant plume mode in this revised TUPOS are the same with the terrain option turned on as for flat terrain. This would seem reasonable as concentrations will be nearly uniform vertically at the distances where hesitant plume concentrations are significant. It is important to note that should receptor heights be above ground or receptor elevations relative to stack base exceed 0.5 z_i, the resulting hesitant plume calculations are likely to be underestimated at downwind positions close to the source.

It is important to note and heed the caution expressed by Briggs (1985) on the procedures that he has suggested and that I have incorporarted into this version of TUPOS. He stated: "All recommendations for modeling buoyant plumes ... must be held as especially tentative until data from a larger number of buoyant sources are examined, or reexamined." I agree with his advise. The principal reason for incorporation of these techniques into a modeling framework at this time is so that the techniques are readily available for testing by anyone possessing pertinent data sets.

CHANGES TO PLUME RISE ALGORITHM

In employing the plume rise procedures suggested by Turner (1985), it was found that inconsistent penetration calculations occurred into an elevated inversion as the source buoyancy was increased. In the layer-by-layer approach calculations that resulted in the plume centerline within an neutral-unstable layer resulted in no examination of layers above even though the plume top extended into those layers. This resulted in significant penetration (up to nearly 50%) when comparing plume dimensions with the mixing height.

As buoyancy is increased, as soon as the plume centerline for neutral-unstable conditions was calculated to be above the neutral-unstable layer, the next layer is considered. When this layer is stable, the plume top is calculated to extend only minimally into the layer resulting in only 1 or 2% penetration.

To overcome this sudden decrease in penetration with small changes in input buoyancy flux, the following modifications have been made to the plume rise procedures incorporated into TUPOS-2.0.

In each case of calculation of plume centerline position for neutral-unstable conditions, the calculated plume top is examined to see if it extends above the top of the layer considered. If it does, subsequent layers are examined until a layer includes the plume top. If this (these) subsequent

layer (s) are neutral-unstable, the original calculation stands. If a stable layer is encountered, the penetration for bent-over buoyant plumes expressed as eq. (8.83) in Briggs (1984) is used. The usual result for these cases with calculated neutral-unstable plume centerline beneath the stable layer is no penetration. This allows for a smooth increase of penetration with increased buoyancy.

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Appendix A

This appendix contains the coding changes that were made to TUPOS-1.0 to result in TUPOS-2.0. In general, lines of code that have been changed or are new do not have sequence numbers on the right. The main program has title and date changes and addition of some descriptive information including changing the structure summary.

TU405 has some additions to include some additional information from MPDA that is used in convective scaling considerations.

TU220 has several additional lines to print on the summary the number of hours that were considered as hesitant plume calculations for each source.

TU330 has been revised to include the hesitant plume calculations. Function PWR has been added to aid in making the hesitant plume calculations.

TU435 replaces the previous subroutine to calculate plume rise.

TU510 is new and is used to obtain data for a layer. This replaces the subroutine of the same name.

Subroutines TU440, TU515, TU520, TU530, TU540, and TU550 are deleted. Their functions are accomplished by subroutines TU435 and TU510.

A line has been modified in CHRON so that TUPOS-2.0 will work whether input data are labelled with hours 1 through 24 or 0 through 23.

All replacement or modified routines are included in this Appendix.

The programs INMET and LSTMET were also changed to allow for the addition of the new meteorological variables required for the hesitant plume model.

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C                    TUPOS-2.0 (DATED 86169)
C                    AN AIR QUALITY DISPERSION MODEL IN                  TUP00020
C                    SECTION 2. NON-GUIDELINE MODELS,                    TUP00030
C                    IN UNAMAP (VERSION 6) JUL 86.                       TUP00040
C                    SOURCE: UNAMAP FILE ON EPA'S UNIVAC 1110, RTP, NC.  TUP00050
C                                                                        TUP00060
C * * *  PROGRAM ABSTRACT — TUPOS                                        TUP00070
C                                                                        TUP00080
C            THIS DISPERSION MODELING TECHNIQUE FOR ESTIMATING CONCEN-   TUP00090
C        TRATIONS FROM BUOYANT POINT SOURCES IS BASED UPON GAUSSIAN      TUP00100
C        ASSUMPTIONS AND CALCULATES THE GAUSSIAN PLUME SPREADING,        TUP00110
C        SIGMA-Y AND SIGMA-Z, UTILIZING HOURLY WIND FLUCTUATION STANDARDTUP00120
C        DEVIATIONS AT PLUME HEIGHT DESCRIBED BY IRWIN (1983).           TUP00130
C        MULTI-LEVEL METEOROLOGICAL INFORMATION FOR LEVELS ABOVE GROUND  TUP00140
C        MUST BE FURNISHED IN A SEPARATE INPUT FILE.  METEOROLOGICAL     TUP00150
C        INPUT FILES COMPATIBLE WITH TUPOS INPUT REQUIREMENTS            TUP00160
C        CAN BE CREATED USING THE METEOROLOGICAL PROCESSOR MPDA-1        TUP00170
C        (PAUMIER, ET AL, 1986).  WIND SPEED                             TUP00180
C        (INTERPOLATED VERTICALLY FROM THE INPUT DATA) IS USED BOTH FOR  TUP00190
C        ESTIMATION OF PLUME RISE AND FOR DILUTION.  WIND DIRECTION AT   TUP00200
C        THE PLUME HEIGHT IS USED AS THE TRANSPORT DIRECTION.  PLUME     TUP00210
C        RISE IS CALCULATED IN A LAYER-BY-LAYER MANNER USING THE INPUT   TUP00220
C        TEMPERATURE AND WIND SPEED PROFILES (TURNER, 1985).  TO ACCOUNTTUP00230
C        FOR PLUME PENETRATION ABOVE THE MIXING HEIGHT, TUPOS USES THE   TUP00240
C        "TOP HAT" DISTRIBUTION RECOMMENDED BY BRIGGS (1975).            TUP00250
C        DISPERSION IS CALCULATED FROM,                                  TUP00260
C                                                                        TUP00270
C                          SIGY = X * SIGA * FY                          TUP00280
C                                                                        TUP00290
C                          SIGZ = X * SIGE * FZ                          TUP00300
C                                                                        TUP00310
C        WHERE SIGY AND SIGZ ARE THE STANDARD DEVIATION OF THE HORIZON-  TUP00320
C        TAL AND VERTICAL WIND ANGLES, RESPECTIVELY; AND FY AND FZ ARE   TUP00330
C        FUNCTIONS OF TRAVEL TIME AND STABILITY.  OPTIONS ARE AVAILABLE  TUP00340
C        FOR TERRAIN ADJUSTMENT, STACK DOWNWASH, GRADUAL PLUME RISE, ANDTUP00350
C        BUOYANCY-INDUCED DISPERSION.  COMPUTATIONS CAN BE MADE FOR ANY  TUP00360
C        NUMBER OF POINT SOURCES AT ANY NUMBER OF RECEPTOR LOCATIONS;    TUP00370
C        THE MAXIMUM NUMBER OF EACH IS SET AT THE TIME OF PROGRAM        TUP00380
C        COMPILATION.  TUPOS-2.0 ADDS A HESITANT PLUME MODEL.  THIS IS
C        EMPLOYED WHEN F* EXCEEDS 0.09.
C                                                                        TUP00400
C            OUTPUT PRINCIPALLY CONSISTS OF TAPE OR DISK CONCENTRATION   TUP00410
C        FILES WHICH ARE THEN ANALYZED AND SUMMARIZED BY A POSTPRO-      TUP00420
C        CESSOR, SUCH AS TUPOS-P (TURNER ET AL., 1985).  AN HOURLY       TUP00430
C        CONCENTRATION FILE IS AUTOMATICALLY CREATED BY TUPOS; THE USER  TUP00440
C        HAS THE OPTION OF CREATING A PARTIAL CONCENTRATION FILE.  FOR   TUP00450
C        CONVENIENCE, A BRIEF SUMMARY OF THE SIMULATION IS PRINTED;      TUP00460
C        HOWEVER, THE USER IS ENCOURAGED TO EXERCISE THE POSTPROCESSOR   TUP00470
C        TO OBTAIN A DETAILED LISTING OF THE RESULTS.                    TUP00480
C                                                                        TUP00490
C                                                                        TUP00500
C * * *  REFERENCES                                                      TUP00510
C                                                                        TUP00520
C        BRIGGS, G. A.  1975.  PLUME RISE PREDICTIONS.  IN:  LECTURES    TUP00530
C           ON AIR POLLUTION AND ENVIRONMENTAL IMPACT ANALYSIS, D. A.    TUP00540
C           HAUGEN (ED.).  AMER. METEOROL. SOC., BOSTON, MA.  PP 59-111.TUP00550
C                                                                        TUP00560
C        IRWIN, J. S.  1983.  ESTIMATING PLUME DISPERSION -- A COMPARI-  TUP00570
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C           APPLIED METEOROLOGY 22: 92-114.                              TUP00590
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C        PAUMIER, J., D. STINSON, T. KELLY, C. BOLLINGER, AND J. S.      TUP00610
C           IRWIN, 1986.  MPDA-1: A METEOROLOGICAL PROCESSOR FOR         TUP00620
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C                                                                        TUP00660
C        PIERCE, THOMAS E., AND TURNER, D. BRUCE, 1980: USER'S GUIDE     TUP00670
C           FOR MPTER - A MULTIPLE POINT GAUSSIAN DISPERSION ALGORITHM   TUP00680
C           WITH OPTIONAL TERRAIN ADJUSTMENT.  EPA-600/8-80-016.  U. S. TUP00690
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C                    TUPOS-2.0 (DATED 86169)
C                    AN AIR QUALITY DISPERSION MODEL IN                    TUP00020
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C                    IN UNAMAP (VERSION 6) JUL 86.                         TUP00040
C                    SOURCE: UNAMAP FILE ON EPA'S UNIVAC 1110, RTP, NC.TUP00050
C                                                                          TUP00060
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C                                                                          TUP00080
C          THIS DISPERSION MODELING TECHNIQUE FOR ESTIMATING CONCEN-      TUP00090
C       TRATIONS FROM BUOYANT POINT SOURCES IS BASED UPON GAUSSIAN        TUP00100
C       ASSUMPTIONS AND CALCULATES THE GAUSSIAN PLUME SPREADING,          TUP00110
C       SIGMA-Y AND SIGMA-Z, UTILIZING HOURLY WIND FLUCTUATION STANDARDTUP00120
C       DEVIATIONS AT PLUME HEIGHT DESCRIBED BY IRWIN (1983).             TUP00130
C       MULTI-LEVEL METEOROLOGICAL INFORMATION FOR LEVELS ABOVE GROUND    TUP00140
C       MUST BE FURNISHED IN A SEPARATE INPUT FILE.  METEOROLOGICAL       TUP00150
C       INPUT FILES COMPATIBLE WITH TUPOS INPUT REQUIREMENTS              TUP00160
C       CAN BE CREATED USING THE METEOROLOGICAL PROCESSOR MPDA-1          TUP00170
C       (PAUMIER, ET AL, 1986).  WIND SPEED                               TUP00180
C       (INTERPOLATED VERTICALLY FROM THE INPUT DATA) IS USED BOTH FOR    TUP00190
C       ESTIMATION OF PLUME RISE AND FOR DILUTION.  WIND DIRECTION AT     TUP00200
C       THE PLUME HEIGHT IS USED AS THE TRANSPORT DIRECTION.  PLUME       TUP00210
C       RISE IS CALCULATED IN A LAYER-BY-LAYER MANNER USING THE INPUT     TUP00220
C       TEMPERATURE AND WIND SPEED PROFILES (TURNER, 1985).  TO ACCOUNTTUP00230
C       FOR PLUME PENETRATION ABOVE THE MIXING HEIGHT, TUPOS USES THE     TUP00240
C       "TOP HAT" DISTRIBUTION RECOMMENDED BY BRIGGS (1975).              TUP00250
C       DISPERSION IS CALCULATED FROM,                                    TUP00260
C                                                                          TUP00270
C                          SIGY = X * SIGA * FY                            TUP00280
C                                                                          TUP00290
C                          SIGZ = X * SIGE * FZ                            TUP00300
C                                                                          TUP00310
C       WHERE SIGY AND SIGZ ARE THE STANDARD DEVIATION OF THE HORIZON-    TUP00320
C       TAL AND VERTICAL WIND ANGLES, RESPECTIVELY; AND FY AND FZ ARE     TUP00330
C       FUNCTIONS OF TRAVEL TIME AND STABILITY.  OPTIONS ARE AVAILABLE    TUP00340
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C       BUOYANCY-INDUCED DISPERSION.  COMPUTATIONS CAN BE MADE FOR ANY    TUP00360
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C       THE MAXIMUM NUMBER OF EACH IS SET AT THE TIME OF PROGRAM          TUP00380
C       COMPILATION.  TUPOS-2.0 ADDS A HESITANT PLUME MODEL.  THIS IS
C       EMPLOYED WHEN F* EXCEEDS 0.09.
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C          OUTPUT PRINCIPALLY CONSISTS OF TAPE OR DISK CONCENTRATION      TUP00410
C       FILES WHICH ARE THEN ANALYZED AND SUMMARIZED BY A POSTPRO-        TUP00420
C       CESSOR, SUCH AS TUPOS-P (TURNER ET AL., 1985).  AN HOURLY         TUP00430
C       CONCENTRATION FILE IS AUTOMATICALLY CREATED BY TUPOS; THE USER    TUP00440
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C       CONVENIENCE, A BRIEF SUMMARY OF THE SIMULATION IS PRINTED;        TUP00460
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C * * * AUTHORS OF MODEL CODE FOR TUPOS TUP00900
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C #AEROCOMP, INC. TUP00940
C TUP00950
C TUP00960
C * * * ACKNOWLEDGMENTS TUP00970
C TUP00980
C THE AUTHORS OF THE MODEL CODE ARE GRATEFUL TO ALFREIDA D. TUP00990
C RANKINS FOR HER COMPUTER ASSISTANCE AND EXPERTISE, TO THOMAS TUP01000
C E. PIERCE FOR HIS WORK ON THE MPTER WHICH FORMED A CONVENIENT TUP01010
C FOUNDATION FOR THIS MODEL, AND TO JOHN S. IRWIN FOR HELPFUL TUP01020
C DISCUSSIONS AND DETAILED EXAMINATION OF MODEL CODE. TUP01030
C TUP01040
C A MODEL IS ONLY AS GOOD AS ITS WEAKEST INPUT DATA AND IT TUP01050
C SHOULD BE NOTED THAT THE ENVIRONMENTAL OPERATIONS BRANCH HAS TUP01060
C BEGUN WORK BY CONTRACT AND INTERAGENCY AGREEMENT POINTED TUP01070
C TOWARD EVALUATING VARIOUS METEOROLOGICAL INSTRUMENT SYSTEMS AS TUP01080
C TO THEIR ABILITY TO MEASURE ATMOSPHERIC VELOCITY AND TUP01090
C TURBULENCE. PROJECT OFFICER FOR THIS EFFORT IS DR. P. L. TUP01100
C FINKELSTEIN. TWO REPORTS RESULTING FROM THIS EFFORT ARE: TUP01110
C TUP01120
C KAIMAL, J.C., J. E. GAYNOR, P. L. FINKELSTEIN, M. E. TUP01130
C GRAVES AND T. J. LOCKHART, 1985: AN EVALUATION OF TUP01140
C WIND MEASUREMENTS BY FOUR DOPPLER SODARS. EPA-600/ TUP01150
C 3-84-111. U. S. ENVIRONMENTAL PROTECTION AGENCY. TUP01160
C RESEARCH TRIANGLE PARK, NC. 124 PP. (AVAILABLE TUP01170
C ONLY FROM NTIS, ACCESSION NUMBER PB85-115 301.) TUP01180
C TUP01190
C KAIMAL, J.C., J. E. GAYNOR, P. L. FINKELSTEIN, M. E. TUP01200
C GRAVES AND T. J. LOCKHART, 1985: A FIELD COMPARISON TUP01210
C OF IN SITU METEOROLOGICAL SENSORS. EPA-600/ TUP01220
C 3-85-057. U. S. ENVIRONMENTAL PROTECTION TUP01230
C AGENCY. RESEARCH TRIANGLE PARK, NC. 108 PP. TUP01240
C (AVAILABLE ONLY FROM NTIS, ACCESSION NUMBER TUP01250
C PB85-196 988.) TUP01260
C TUP01270
C * * * PROGRAM SUPPORTED BY: TUP01280
C TUP01290
C ENVIRONMENTAL OPERATIONS BRANCH TUP01300
C MAIL DROP 80, EPA TUP01310
C RESEARCH TRIANGLE PARK, NC 27711 TUP01320
C TUP01330
C PHONE: (919) 541-4564, FTS 629-4564. TUP01340
C TUP01350

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C                                                                       TUP01360
C * * *  TWO SYSTEMS OF LENGTH AND COORDINATES ARE USED IN THIS PROGRAM:TUP01370
C                                                                       TUP01380
C              THE FIRST SYSTEM, USER UNITS, IS SELECTED BY THE USER AND TUP01390
C        NORMALLY USES THE COORDINATE SYSTEM OF THE EMISSION INVENTORY. TUP01400
C        ALL LOCATIONS INPUT BY THE USER (SUCH AS SOURCES AND RECEPTORS)TUP01410
C        ARE IN THIS SYSTEM. ALSO AS A CONVENIENCE TO THE USER, ALL     TUP01420
C        LOCATIONS ON OUTPUT ARE ALSO IN THIS SYSTEM.                   TUP01430
C                                                                       TUP01440
C              THE SECOND SYSTEM, X, Y, IS AN UPWIND, CROSSWIND         TUP01450
C        COORDINATE SYSTEM RELATIVE TO EACH RECEPTOR.  THE X-AXIS IS    TUP01460
C        DIRECTED UPWIND (SAME AS WIND DIRECTION FOR THE HOUR).  IN     TUP01470
C        ORDER TO DETERMINE DISPERSION PARAMETER VALUES AND EVALUATE    TUP01480
C        EQUATIONS FOR CONCENTRATION ESTIMATES, DISTANCES IN THIS       TUP01490
C        SYSTEM MUST BE IN KILOMETERS. THIS SYSTEM IS INTERNAL AND IS   TUP01500
C        NOT APPARENT TO THE USER.                                      TUP01510
C                                                                       TUP01520
C * * *  INPUT/OUTPUT INFORMATION                                       TUP01530
C                                                                       TUP01540
C        FORTRAN       DATA SET                        I/O UNIT         TUP01550
C         UNIT                                                          TUP01560
C           5           CONTROL INPUT                   READER OR DISK   TUP01570
C           6           OUTPUT                          PRINTER OR DISK  TUP01580
C           9           METEOROLOGY (IN)                DISK OR TAPE     TUP01590
C          10           HOURLY EMISSIONS (IN)           DISK OR TAPE     TUP01600
C          12           HOURLY CONCENTRATIONS (OUT)     DISK OR TAPE     TUP01610
C          14           PARTIAL CONCENTRATIONS (OUT)    DISK OR TAPE     TUP01620
C                                                                       TUP01630
C * * *  STRUCTURE AND MODULE SUMMARY                                   TUP01640
C                                                                       TUP01650
C TU100 - MODEL MULTILEVEL BUOYANT PLUME                                TUP01660
C         TU210 - PROCESS CONTROL INPUTS                                TUP01670
C                 TU305 - GET MET FILE HEADER                           TUP01680
C                         TU405 - READ MET FILE                         TUP01690
C                 TU310 - PROCESS SOURCE INPUT                          TUP01700
C                         TU410 - CHARACTERIZE SOURCES                  TUP01710
C                         TU415 - RANK SIGNIFICANT SOURCES              TUP01720
C                 TU315 - PROCESS RECEPTOR INPUT                        TUP01730
C                         TU420 - GENERATE POLAR RECEPTORS              TUP01740
C                         TU425 - PRODUCE RECEPTOR TABLE                TUP01750
C         TU220 - EXECUTE DISPERSION SIMULATION                         TUP01760
C                         CHRON - DATE/TIME TO INTEGER                  TUP01770
C                         ICHRON - INTEGER TO DATE/TIME                 TUP01780
C                 TU320 - GET HOURLY MET DATA                           TUP01790
C                         (TU405 - READ MET FILE)
C                         CHRON - DATE/TIME TO INTEGER                  TUP01810
C                 TU325 - GET HOURLY EMISSIONS                          TUP01820
C                         TU430 - READ EMISSIONS FILE                   TUP01830
C                         CHRON - DATE/TIME TO INTEGER                  TUP01840
C                 TU330 - CALCULATE CONCENTRATIONS                      TUP01850
C                         TU435 - CALCULATE LAYER-BY-LAYER PLUME RISE   TUP01860
C                                   AND PENETRATION
C                                 TU510 - OBTAIN DATA FOR A LAYER
C                         TU445 - CALCULATE EMISSION METEOROLOGY        TUP01970
C                         TU450 - CALCULATE DISPERSION PARAMETERS       TUP01980
C                         TU455 - CALCULATE RELATIVE CONCENTRATION      TUP01990
C                         ZF    - FIND HEIGHT OF MAXIMUM.               TUP02000
C                 TU335 - UPDATE MAXIMUM CONCENTRATION                  TUP02010
C                 TU340 - OUTPUT HOURLY RESULTS                         TUP02020
C                                                                       TUP02030
      PARAMETER (NLMAX=20,NPTMAX=25,NREMAX=180,NDMAX=40)                TUP02040
C                                                                       TUP02050
C         USE OF PARAMETER STATEMENT SETS: MAXIMUMS FOR                 TUP02060
C          NUMBER OF VERTICAL LEVELS FOR METEOROLOGY (NLMAX),           TUP02070
C          NUMBER OF POINT SOURCES (NPTMAX),                            TUP02080
C          NUMBER OF RECEPTORS (NREMAX), AND                            TUP02090
C          NUMBER OF LINES OF DESCRIPTION OF MET INFORMATION (NDMAX).   TUP02100
C                                                                       TUP02110
      COMMON /RUNCOM/CELM,CONTWO,CTER,HAFL,TLOS,CONTER(4),IYRS,IDYS,    TUP02120
     1               IHRS,IHLIM,IOPT,IOPB,IOPD,IOPG,IOPM,IOPQ,IOPR,     TUP02130
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     2                IOPWPC,NPOL,LINE1(20),LINE2(20),LINE3(20),NPRNT     TUP02140
      COMMON /METCOM/DTHDZ(NLMAX),SAL(NLMAX),SEL(NLMAX),TL(NLMAX),       TUP02150
     1               UL(NLMAX),WDL(NLMAX),ZL(NLMAX),KLASS,LMX,MDATA,     TUP02160
     2               MDATB,METNAM(2),MYR,MJD,MHR,ND,NLLIM,DESC(18,NDMAX)TUP02170
      COMMON /SORCOM/D(NPTMAX),PNAME(3,NPTMAX),PSH(NPTMAX),QJ(NPTMAX),   TUP02180
     1               QELEV(NPTMAX),QEAST(NPTMAX),QNORD(NPTMAX),          TUP02190
     2               TS(NPTMAX),VS(NPTMAX),IQYR,IQJD,IQHR,NPTLIM,        TUP02200
     3               IMPS(NPTMAX)                                        TUP02210
      COMMON /RECCOM/ELR(NREMAX),PARTC(NREMAX,NPTMAX),PHCHI(NREMAX),     TUP02220
     1               RNAME(2,NREMAX),RREC(NREMAX),SREC(NREMAX),          TUP02230
     2               STAR(2,NREMAX),ZR(NREMAX),NRELIM                    TUP02240
      COMMON /INOUT/ IN,IO                                               TUP02250
      DATA BLANK/' '/                                                    TUP02260
C                                                                        TUP02270
      CALL WSTCLK
C        WRITE HEADER.                                                   TUP02280
C                                                                        TUP02290
      WRITE (6,1234)                                                     TUP02300
 1234 FORMAT ('1',21X,'TUPOS-2.0 (DATED 86169)'/
     1 22X,'AN AIR QUALITY DISPERSION MODEL IN'/                         TUP02320
     2 22X,'SECTION 2. NON-GUIDELINE MODELS,'/                           TUP02330
     3 22X,'IN UNAMAP (VERSION 6) JUL 86.'/                              TUP02340
     4 22X,'SOURCE: UNAMAP FILE ON EPA''S UNIVAC 1110, RTP, NC.')        TUP02350
C                                                                        TUP02360
C          INITIALIZE.                                                   TUP02370
C                                                                        TUP02380
      IN = 5                                                             TUP02390
      IO = 6                                                             TUP02400
      ICOND = 0                                                          TUP02410
      DO 20 I = 1,2                                                      TUP02420
         DO 10 J = 1,NREMAX                                              TUP02430
            STAR(I,J) = BLANK                                            TUP02440
   10    CONTINUE                                                        TUP02450
   20 CONTINUE                                                           TUP02460
C                                                                        TUP02470
C           PROCESS CONTROL INPUTS.                                      TUP02480
C                                                                        TUP02490
      CALL TU210(ICOND)                                                  TUP02500
      IF (ICOND .EQ. 0) GO TO 100                                        TUP02510
      WRITE(IO,1000)ICOND                                                TUP02520
      GO TO 999                                                          TUP02530
C                                                                        TUP02540
C          EXECUTE DISPERSION SIMULATION.                                TUP02550
C                                                                        TUP02560
  100 CALL TU220(ICOND)                                                  TUP02570
      IF (ICOND .EQ. 0) GO TO 200                                        TUP02580
      WRITE(IO,1000)ICOND                                                TUP02590
      GO TO 999                                                          TUP02600
C                                                                        TUP02610
C        SUCCESSFUL EXECUTION.                                           TUP02620
C                                                                        TUP02630
  200 WRITE(IO,1010)                                                     TUP02640
C                                                                        TUP02650
999   CALL WAUDIT
      STOP                                                               TUP02660
C                                                                        TUP02670
C          FORMAT STATEMENTS.                                            TUP02680
C                                                                        TUP02690
 1000 FORMAT('0*** EXECUTION TERMINATED, CONDITION CODE = ',I5)          TUP02700
 1010 FORMAT('0*** NORMAL TERMINATION ***')                              TUP02710
      END                                                                TUP02720
C
      SUBROUTINE TU405(KMET,ICOND,IEOF,MISG)                             TUP07460
C        405-READ-MET-FILE                                               TUP07470
C                                                                        TUP07480
C        ARGUMENT LIST:                                                  TUP07490
C          INPUT:    KMET  - READ COUNTER                               TUP07500
C          OUTPUT:   ICOND - CONDITION INDICATOR (0 = NO ERROR)         TUP07510
C                    IEOF  - END OF FILE INDICATOR (1 = END OF FILE)    TUP07520
C                                                                        TUP07530
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C         CALLING ROUTINES:                                              TUP07540
C           TU305, TU320                                                 TUP07550
C                                                                        TUP07560
C         DESCRIPTION:                                                   TUP07570
C           THIS MODULE PERFORMS ALL I/O TO THE METEOROLOGY FILE,        TUP07580
C           UNIT 9.  METEOROLOGY DATA IS READ INTO COMMON METCOM.        TUP07590
C           ERRORS ARE INDICATED BY PASSING A NONZERO VALUE THROUGH      TUP07600
C           ICOND.  END OF FILE IS INDICATED BY PASSING A VALUE OF ONE   TUP07610
C           THROUGH IEOF.  KMET IS USED TO RECORD BOTH THE NUMBER OF     TUP07620
C           RECORDS READ AND TO INDICATE THE TYPE OF RECORD BEING READ   TUP07630
C           (HEADER OR HOURLY).                                          TUP07640
C                                                                        TUP07650
C * * *   INPUT FILE (UNIT 9) - METEOROLOGICAL DATA MUST BE ENTERED VIA  TUP07660
C                                 THIS FILE.                             TUP07670
C                                                                        TUP07680
C         THIS FILE IS UNFORMATTED.                                      TUP07690
C                                                                        TUP07700
C         THE ASSUMPTION IS MADE HERE THAT THE USER IS DEFINING THE      TUP07710
C          VARIATION OF METEOROLOGICAL PARAMETERS WITH HEIGHT BY         TUP07720
C          INCLUDING SUFFICIENT LEVELS SUCH THAT LINEAR INTERPOLATION    TUP07730
C          WITH HEIGHT BETWEEN LEVELS WILL BE ADEQUATE.                  TUP07740
C                                                                        TUP07750
C         ANY INFORMATION REQUIRED FOR A HEIGHT BELOW THE HEIGHT OF THE  TUP07760
C          LOWEST LEVEL WILL BE ASSIGNED THE VALUE FOR THE LOWEST LEVEL. TUP07770
C          SIMILARLY, ANY INFORMATION REQUIRED FOR A HEIGHT ABOVE THE    TUP07780
C          HEIGHT OF THE HIGHEST LEVEL WILL BE ASSIGNED THE VALUE FOR THETUP07790
C          HIGHEST LEVEL.                                                TUP07800
C                                                                        TUP07810
C       RECORD 1 -- HEADER RECORD (OCCURS ONCE AT TOP OF FILE)           TUP07820
C                                                                        TUP07830
C         METNAM(2)  AN 8 CHARACTER ALPHANUMERIC IDENTIFIER FOR THE MET  TUP07840
C                     DATA.                                              TUP07850
C         MDATA      DATE-TIME OF DATA CREATION, MO DAY YR (6 DIGITS)    TUP07860
C         MDATB      DATE-TIME OF DATA CREATION, HR MIN SEC (6 DIGITS)   TUP07870
C         ND         NUMBER OF 72 CHARACTER ALPHANUMERIC LINES OF        TUP07880
C                     DESCRIPTION.                                       TUP07890
C         DESC       ND LINES OF ALPHANUMERIC INFORMATION (72 CHARACTERS TUP07900
C                     PER LINE) THAT DESCRIBES THE MET DATA.             TUP07910
C                                                                        TUP07920
C       RECORD 2 -- REPETITIVE RECORDS ON MET FILE                       TUP07930
C                                                                        TUP07940
C         MYR        YEAR (2 DIGITS)                                     TUP07950
C         MJD        JULIAN DAY (3 DIGITS)                               TUP07960
C         MHR        HOUR (2 DIGITS)                                     TUP07970
C         NLLIM      NUMBER OF DATA LEVELS THIS HOUR                     TUP07980
C         LMX        THE DATA LEVEL NUMBER OF THE MIXING HEIGHT          TUP07990
C         KLASS      THE STABILITY CATEGORY FOR THIS HOUR                TUP08000
C
C         MSURE      SEVERE WEATHER CODE
C         MSNOW      SNOW AMOUNT
C         MPPT       PRECIPITABLE (LIQUID) AMOUNT
C         MOBST      OBSTRUCTIONS TO VISIBILITY
C         MVIS       HORIZONTAL SURFACE VISIBILITY
C         MCLD       CLOUD AMOUNT
C         STPRES     STATION PRESSURE (MB)
C         SUNANG     SUN ANGLE WITH RESPECT TO HORIZON
C         USTAR      FRICTION VELOCITY (M/S)
C         HSF        SURFACE HEAT FLUX (W/M**2)
C         OBK        MONIN-OBUKHOV LENGTH (M)
C
C         ZL         HEIGHT OF EACH LEVEL (METERS ABOVE GROUND)          TUP08010
C         TL         TEMPERATURE (K) FOR EACH LEVEL                      TUP08020
C         WDL        WIND DIRECTION (DEGREES AZIMUTH, CLOCKWISE FROM     TUP08030
C                     NORTH) FOR EACH LEVEL                              TUP08040
C         UL         WIND SPEED (M/SEC) FOR EACH LEVEL                   TUP08050
C         SAL        SIGMA-A STANDARD DEVIATION OF WIND AZIMUTH          TUP08060
C                     (RADIANS) FOR EACH LEVEL                           TUP08070
C         SEL        SIGMA-E STANDARD DEVIATION OF WIND ELEVATION ANGLE  TUP08080
C                     (RADIANS) FOR EACH LEVEL                           TUP08090
C                                                                        TUP08100
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      PARAMETER (NLMAX=20,NDMAX=40)                                     TUP08110
      COMMON /METCOM/DTHDZ(NLMAX),SAL(NLMAX),SEL(NLMAX),TL(NLMAX),      TUP08120
     1               UL(NLMAX),WDL(NLMAX),ZL(NLMAX),KLASS,LMX,MDATA,    TUP08130
     2               MDATB,METNAM(2),MYR,MJD,MHR,ND,NLLIM,
     3               DESC(18,NDMAX),NFLG(NLMAX)
      COMMON /HEST/ HSTAR,WSTAR,FSTAR
      DATA AMISG /-9999./
C                                                                       TUP08150
      IEOF = 0                                                          TUP08160
C                                                                       TUP08170
C         DETERMINE IF THIS IS THE FIRST READ OF MET FILE.              TUP08180
C                                                                       TUP08190
      IF (KMET .GT. 0) GO TO 100                                        TUP08200
C                                                                       TUP08210
C         PROCESS HEADER RECORD.                                        TUP08220
C                                                                       TUP08230
      READ(9,ERR=10,END=20) METNAM,MDATA,MDATB,ND,                      TUP08240
     1                      ((DESC(I,J), I = 1,18), J = 1,ND)           TUP08250
      GO TO 999                                                         TUP08260
   10 ICOND = 40501                                                     TUP08270
      GO TO 999                                                         TUP08280
   20 IEOF = 1                                                          TUP08290
      GO TO 999                                                         TUP08300
C                                                                       TUP08310
C         PROCESS HOURLY RECORDS.                                       TUP08320
C                                                                       TUP08330
  100 READ (9,ERR=110,END=120) MYR,MJD,MHR,NLLIM,LMX,KLASS,
     1 MSURE,MSNOW,MPPT,MOBST,MVIS,MCLD,STPRES,SUNANG,
     2 USTAR,HSF,OBK,
     3 (ZL(I),TL(I),WDL(I),UL(I),SAL(I),SEL(I), I = 1,NLLIM)
C
      IF (KLASS.GE.1.AND.KLASS.LE.4) GO TO 30
      MISG = 100
      GO TO 999
C                                                                       TUP08370
   30 ZI = ZL(LMX)
      IF (ZI.EQ.AMISG) GO TO 200
      IF (HSF.EQ.AMISG) GO TO 300
      IF (STPRES.EQ.AMISG) STPRES = 990.
      HSTAR = 0.028 * HSF/STPRES
      IF (HSTAR.LT.0.) THEN
      WSTAR = -(-HSTAR*ZI) ** 0.333333
      ELSE
      WSTAR = (HSTAR * ZI) ** 0.333333
      END IF
      GO TO 999
  200 MISG = 200
  300 HSTAR = AMISG
      WSTAR = AMISG
      GO TO 999                                                         TUP08380
  110 ICOND = 40502                                                     TUP08390
      GO TO 999                                                         TUP08400
  120 IEOF = 1                                                          TUP08410
C                                                                       TUP08420
  999 RETURN                                                            TUP08430
      END                                                               TUP08440
C
      SUBROUTINE TU220(ICOND)                                           TUP12460
C        220-EXECUTE-DISPERSION-SIMULATION                              TUP12470
C                                                                       TUP12480
C        PARAMETER LIST:                                                TUP12490
C          OUTPUT:  ICOND - CONDITION INDICATOR (0 = NO ERROR)          TUP12500
C                                                                       TUP12510
C        CALLING ROUTINES:                                              TUP12520
C          MAIN                                                         TUP12530
C                                                                       TUP12540
C        SUBPROGRAMS CALLED:                                            TUP12550
C          TU320, TU325, TU330, TU335, TU340, CHRON, ICHRON             TUP12560
C                                                                       TUP12570
C        DESCRIPTION:                                                   TUP12580
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C          THIS MODULE ACCOMPLISHES THE ACTUAL SIMULATION.  TWO OUTPUT  TUP12590
C          FILES CAN BE CREATED BY THIS MODULE.  THEY ARE:              TUP12600
C                                                                       TUP12610
C             (1)  HOURLY CONCENTRATIONS. UNIT 12                       TUP12620
C             (2)  HOURLY PARTIAL CONCENTRATIONS (OPTIONAL). UNIT 14    TUP12630
C                                                                       TUP12640
C        NOTE THAT BECAUSE OF THE ORGANIZATION OF THE PROGRAM           TUP12650
C          (NESTING OF LOOPS, SINCE EACH SOURCE MAY HAVE SOMEWHAT       TUP12660
C          DIFFERENT METEOROLOGY), THE PARTIAL CONCENTRATION FILE       TUP12670
C          GENERATED BY THIS PROGRAM IS ORGANIZED DIFFERENT FROM THAT   TUP12680
C          RESULTING FROM MPTER.                                        TUP12690
C                                                                       TUP12700
C***  OUTPUT FILE (UNIT 12) HOURLY CONCENTRATIONS                       TUP12710
C                                                                       TUP12720
C     RECORD TYPE 1                                                     TUP12730
C        IFLAGH        FLAG TO INDICATE HOURLY CONCENTRATION FILE; = 12 TUP12740
C                                                                       TUP12750
C     RECORD TYPE 2                                                     TUP12760
C        LINE1         80 ALPHANUMERIC CHARACTERS FOR TITLE             TUP12770
C        LINE2         80 ALPHANUMERIC CHARACTERS FOR TITLE             TUP12780
C        LINE3         80 ALPHANUMERIC CHARACTERS FOR TITLE             TUP12790
C                                                                       TUP12800
C     RECORD TYPE 3  (MET FILE HEADER RECORD)                           TUP12810
C        METNAM        AN 8 CHARACTER ALPHANUMERIC IDENTIFIER FOR THE MET TUP12820
C                       DATA.                                           TUP12830
C        MDATA         DATE-TIME OF DATA CREATION.  MO DAY YR (6 DIGITS). TUP12840
C        MDATB         DATE-TIME OF DATA CREATION.  HR MIN SEC (6 DIGITS).TUP12850
C        ND            NUMBER OF 72 CHARACTER ALPHANUMERIC LINES OF      TUP12860
C                       DESCRIPTION                                     TUP12870
C        DESC          ND LINES OF ALPHANUMERIC INFORMATION (72 CHARACTERSTUP12880
C                       PER LINE) THAT DESCRIBES THE MET DATA           TUP12890
C                                                                       TUP12900
C     RECORD TYPE 4                                                     TUP12910
C        NPOL          4 CHARACTER POLLUTANT NAME                       TUP12920
C        CONTWO        MULTIPLIER TO CONVERT USER UNITS TO KILOMETERS   TUP12930
C        CEIM          MULTIPLIER TO CONVERT USER HEIGHT UNITS TO METERS TUP12940
C        HAFL          POLLUTANT HALF-LIFE (SECONDS).  AN ENTRY OF ZERO TUP12950
C                       WILL CAUSE NO POLLUTANT LOSS.                   TUP12960
C        NPTLIM        NUMBER OF POINT SOURCES CONSIDERED               TUP12970
C        NRELIM        NUMBER OF RECEPTORS CONSIDERED                   TUP12980
C                                                                       TUP12990
C     RECORD TYPE 5                                                     TUP13000
C        IOPT          TERRAIN ADJUSTMENT OPTION                        TUP13010
C        IOPB          BUOYANCY-INDUCED DISPERSION OPTION               TUP13020
C        IOPD          STACK-TIP DOWNWASH OPTION                        TUP13030
C        IOPG          GRADUAL PLUME RISE OPTION                        TUP13040
C        IOPM          TEST AGAINST BOUNDARY-LAYER HEIGHT AT NIGHT      TUP13050
C        IOPQ          HOURLY EMISSIONS INPUT OPTION                    TUP13060
C        IOPR          POLAR COORDINATE RECEPTOR OPTION                 TUP13070
C                                                                       TUP13080
C     RECORD TYPE 6 (WRITE IF IOPT = 1)                                 TUP13090
C        CONTER(4)     TERRAIN ADJUSTMENT FACTORS                       TUP13100
C                                                                       TUP13110
C     RECORD TYPE 7  -  NPTLIM RECORDS (ONE FOR EACH SOURCE)            TUP13120
C        PNAME         12 CHARACTER SOURCE IDENTIFICATION               TUP13130
C        QEAST         EAST COORDINATE OF SOURCE (USER UNITS)           TUP13140
C        QNORD         NORTH COORDINATE OF SOURCE (USER UNITS)          TUP13150
C        QJ(NPT)       EMISSION RATE (G/SEC) FOR POLLUTANT NPOL         TUP13160
C        PSH           PHYSICAL STACK HEIGHT (M)                        TUP13170
C        TS            STACK GAS TEMPERATURE (K)                        TUP13180
C        D             STACK DIAMETER (M)                               TUP13190
C        VS            STACK GAS EXIT VELOCITY (G/SEC)                  TUP13200
C        QELEV         STACK BASE GROUND-LEVEL ELEVATION (USER HEIGHT   TUP13210
C                       UNITS)                                          TUP13220
C        IMPS          ARRAY OF SOURCE NUMBERS IN ORDER OF SIGNIFICANCE TUP13230
C                                                                       TUP13240
C     RECORD TYPE 8  -  NRELIM RECORDS (ONE FOR EACH RECEPTOR)          TUP13250
C        RNAME         8 CHARACTER RECEPTOR IDENTIFICATION              TUP13260
C        RREC          EAST COORDINATE OF RECEPTOR (USER UNITS)         TUP13270
C        SREC          NORTH COORDINATE OF RECEPTOR (USER UNITS)        TUP13280
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C         ZR            RECEPTOR HEIGHT ABOVE LOCAL GROUND-LEVEL (M)        TUP13290
C         ELR           RECEPTOR GROUND-LEVEL ELEVATION (USER HEIGHT UNITS)TUP13300
C         STAR          FLAG TO INDICATE RECEPTOR STATUS, I.E.,            TUP13310
C                         *   RECEPTOR ELEVATION IS BELOW LOWEST STACK BASETUP13320
C                             ELEVATION                                    TUP13330
C                         **  RECEPTOR ELEVATION IS ABOVE LOWEST STACK TOP TUP13340
C                             ELEVATION.                                   TUP13350
C                                                                          TUP13360
C     RECORD TYPES 1-8 OCCUR ONCE AT THE TOP OF THE FILE.                  TUP13370
C                                                                          TUP13380
C          RECORDS 9, 10, AND 11 ARE REPEATED IN                           TUP13390
C           SEQUENCE FOR EACH HOUR.                                        TUP13400
C                                                                          TUP13410
C     RECORD TYPE 9 (ONE FOR EACH HOUR)                                    TUP13420
C         IYR           2-DIGIT YEAR                                       TUP13430
C         IDY           JULIAN DAY                                         TUP13440
C         LH            HOUR                                               TUP13450
C                                                                          TUP13460
C     RECORD TYPE 10 (ONE FOR EACH HOUR)                                   TUP13470
C         HSAV          EFFECTIVE PLUME HEIGHTS FOR EACH SOURCE            TUP13480
C         DSAV          DISTANCE TO FINAL RISE FOR EACH SOURCE             TUP13490
C                                                                          TUP13500
C     RECORD TYPE 11 (ONE FOR EACH HOUR)                                   TUP13510
C         PHCHI(NRE)    CONCENTRATIONS (G/M**3) AT EACH RECEPTOR           TUP13520
C                                                                          TUP13530
C                                                                          TUP13540
C***  OUTPUT FILE (UNIT 14) PARTIAL CONCENTRATIONS (CREATED IF IOPWPC=1)TUP13550
C                                                                          TUP13560
C     RECORD TYPE 1                                                        TUP13570
C         IFLAGP        FLAG TO INDICATE PARTIAL CONCENTRATION FILE; = 14  TUP13580
C                                                                          TUP13590
C     ***  RECORD TYPES 2-8 ARE IDENTICAL TO THOSE IN THE HOURLY           TUP13600
C          CONCENTRATION FILE (UNIT 12).                                   TUP13610
C                                                                          TUP13620
C     ***  RECORD TYPES 1-8 OCCUR ONCE AT THE TOP OF THE FILE.             TUP13630
C                                                                          TUP13640
C          ONE RECORD 9 AND NPTLIM RECORD 10'S ARE                         TUP13650
C           WRITTEN EACH HOUR.                                             TUP13660
C                                                                          TUP13670
C     RECORD TYPE 9 (ONE FOR EACH HOUR)                                    TUP13680
C         IYR           2-DIGIT YEAR                                       TUP13690
C         IDY           JULIAN DAY                                         TUP13700
C         LH            HOUR                                               TUP13710
C                                                                          TUP13720
C     RECORD TYPE 10 (ONE FOR EACH SOURCE, FOR EACH HOUR)                  TUP13730
C         HSAV (NPT)    EFFECTIVE PLUME HEIGHT                             TUP13740
C         DSAV (NPT)    DISTANCE TO FINAL RISE                             TUP13750
C         PARTC(NRE)    CONCENTRATIONS (G/M**3) AT EACH RECEPTOR FROM      TUP13760
C                        SOURCE NPT (NRE = 1, NRELIM).                     TUP13770
C                                                                          TUP13780
      PARAMETER (NLMAX=20,NPTMAX=25,NREMAX=180,NDMAX=40)                   TUP13790
      DIMENSION HSAV(NPTMAX),DSAV(NPTMAX),CDUM(NREMAX),                    TUP13800
     1          DHDUM(NPTMAX)                                              TUP13810
      COMMON /RUNCOM/CELM,CONTWO,CTER,HAFL,TLOS,CONTER(4),IYRS,IDYS,       TUP13820
     1               IHRS,IHLIM,IOPT,IOPB,IOPD,IOPG,IOPM,IOPQ,IOPR,        TUP13830
     2               IOPWPC,NPOL,LINE1(20),LINE2(20),LINE3(20),NPRNT       TUP13840
      COMMON /METCOM/DTHDZ(NLMAX),SAL(NLMAX),SEL(NLMAX),TL(NLMAX),         TUP13850
     1               UL(NLMAX),WDL(NLMAX),ZL(NLMAX),KLASS,LMX,MDATA,       TUP13860
     2               MDATB,METNAM(2),MYR,MJD,MHR,ND,NLLIM,DESC(18,NDMAX)TUP13870
      COMMON /SORCOM/D(NPTMAX),PNAME(3,NPTMAX),PSH(NPTMAX),QJ(NPTMAX),     TUP13880
     1               QELEV(NPTMAX),QEAST(NPTMAX),QNORD(NPTMAX),            TUP13890
     2               TS(NPTMAX),VS(NPTMAX),IQYR,IQJD,IQHR,NPTLIM,          TUP13900
     3               IMPS(NPTMAX)                                          TUP13910
      COMMON /RECCOM/ELR(NREMAX),PARTC(NREMAX,NPTMAX),PHCHI(NREMAX),       TUP13920
     1               RNAME(2,NREMAX),RREC(NREMAX),SREC(NREMAX),            TUP13930
     2               STAR(2,NREMAX),ZR(NREMAX),NRELIM                      TUP13940
      COMMON /INOUT/ IN,IO                                                 TUP13950
      COMMON /HESFLG/IHFC(NPTMAX)
      DATA IFLAGH,IFLAGP /12,14/                                           TUP13960
C                                                                          TUP13970
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C         WRITE HEADER RECORDS FOR HOURLY CONCENTRATION FILE (UNIT 12).
C
      WRITE(12) IFLAGH
      WRITE(12) LINE1,LINE2,LINE3
      WRITE(12) METNAM,MDATA,MDATB,ND,((DESC(I,J), I = 1,18), J = 1,ND)
      WRITE(12) NPOL,CONTWO,CELM,HAFL,NPTLIM,NRELIM
      WRITE(12) IOPT,IOPB,IOPD,IOPG,IOPM,IOPQ,IOPR
      IF (IOPT .EQ. 1) WRITE(12) (CONTER(I), I = 1,4)
      DO 5 NPT = 1,NPTLIM
    5 WRITE(12) (PNAME(I,NPT), I = 1,3),QEAST(NPT),QNORD(NPT),
     1          QJ(NPT),PSH(NPT),TS(NPT),D(NPT),VS(NPT),
     2          QELEV(NPT),IMPS(NPT)
      DO 10 NRE = 1,NRELIM
         WRITE(12) (RNAME(I,NRE), I = 1,2),RREC(NRE),SREC(NRE),ZR(NRE),
     1             ELR(NRE),(STAR(J,NRE), J = 1,2)
   10 CONTINUE
C
C         WRITE HEADER RECORDS FOR THE PARTIAL CONCENTRATION FILE
C          (UNIT 14).
C
      IF (IOPWPC .EQ. 0) GO TO 20
      WRITE(14) IFLAGP
      WRITE(14) LINE1,LINE2,LINE3
      WRITE(14) METNAM,MDATA,MDATB,ND,((DESC(I,J), I = 1,18), J = 1,ND)
      WRITE(14) NPOL,CONTWO,CELM,HAFL,NPTLIM,NRELIM
      WRITE(14) IOPT,IOPB,IOPD,IOPG,IOPM,IOPQ,IOPR
      IF (IOPT .EQ. 1) WRITE(14) (CONTER(I), I = 1,4)
      DO 13 NPT = 1,NPTLIM
   13 WRITE(14) (PNAME(I,NPT), I = 1,3),QEAST(NPT),QNORD(NPT),
     1          QJ(NPT),PSH(NPT),TS(NPT),D(NPT),VS(NPT),
     2          QELEV(NPT),IMPS(NPT)
      DO 15 NRE = 1,NRELIM
         WRITE(14) (RNAME(I,NRE), I = 1,2),RREC(NRE),SREC(NRE),ZR(NRE),
     1             ELR(NRE),(STAR(J,NRE), J = 1,2)
   15 CONTINUE
C
C         INITIALIZE PRIOR TO START OF SIMULATION.
C
   20 CALL CHRON(IYRS,IDYS,IHRS,IHRBEG)
      IF (IHRBEG .GT. 0) GO TO 30
      ICOND = 22001
      GO TO 900
   30 IHREX = IHRBEG - 1
      IHREND = IHRBEG + IHLIM - 1
      KMET = 0
      KEMIS = 0
      MYDH = -1
      KMISS = 0
      KINCOM = 0
      NTAH = 0
      NHR = 0
      HMAX = -1.0
      DO 40 NRE = 1,NRELIM
         CDUM(NRE) = -9999.
   40 CONTINUE
      DO 50 NPT = 1,NPTLIM
         DHDUM(NPT) = -9999.
   50 CONTINUE
C
C         INITIALIZE FOR NEXT HOUR.
C
  100 DO 110 NRE = 1,NRELIM
         PHCHI(NRE) = 0.C
  110 CONTINUE
      IHREX = IHREX + 1
      CALL ICHRON(IHREX,IYR,IDY,LH)
      IF ((IYR .GE. 0) .AND. (IDY .GE. 0) .AND. (LH .GE. 0)) GO TO 140
      ICOND = 22002
      GO TO 900
  140 IF (MYDH - IHREX) 150,300,400
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C                                                                       TUP14680
C         GET MET DATA.                                                 TUP14690
C                                                                       TUP14700
  150 MISG = 0                                                          TUP14710
      CALL TU320(IHREX,KMET,MYDH,ICOND,MISG)                            TUP14720
      IF (ICOND .NE. 0) GO TO 900                                       TUP14730
      MIST = MISG                                                       TUP14740
      IF (MYDH - IHREX) 200,300,400                                     TUP14750
C                                                                       TUP14760
C         ERROR READING MET FILE.                                       TUP14770
C                                                                       TUP14780
  200 WRITE(IO,1000) MYDH,IHREX                                         TUP14790
      ICOND = 22003                                                     TUP14800
      GO TO 900                                                         TUP14810
C                                                                       TUP14820
C         HAVE FOUND HOUR OF INTEREST.  CHECK IF MISSING CODE TURNED ON.TUP14830
C                                                                       TUP14840
  300 MISG = MIST                                                       TUP14850
      IF (MISG .GT. 0) GO TO 405                                        TUP14860
      CTER = CONTER(KLASS)                                              TUP14870
C                                                                       TUP14880
C         GET HOURLY EMISSIONS IF IOPQ = 1                              TUP14890
C                                                                       TUP14900
      IF (IOPQ .EQ. 0) GO TO 310                                        TUP14910
      CALL TU325(IHREX,KEMIS,ICOND)                                     TUP14920
      IF (ICOND .NE. 0) GO TO 900                                       TUP14930
C                                                                       TUP14940
C         CALCULATE CONCENTRATIONS                                      TUP14950
C                                                                       TUP14960
  310 CALL TU330(HSAV,DSAV,MISG)                                        TUP14970
      IF (MISG .GT. 0) GO TO 405                                        TUP14980
C                                                                       TUP14990
C         MET DATA IS SUFFICIENT TO COMPLETE SIMULATION FOR THIS HOUR.  TUP15000
C          WRITE HOURLY AND PARTIAL CONCENTRATIONS TO APPROPRIATE FILES.TUP15010
C          INCREMENT COUNTERS.                                          TUP15020
C                                                                       TUP15030
      WRITE(12) IYR,IDY,LH                                              TUP15040
      WRITE(12) (HSAV(NPT),NPT = 1,NPTLIM),(DSAV(NPT), NPT = 1,NPTLIM)  TUP15050
      WRITE(12) (PHCHI(NRE), NRE = 1,NRELIM)                            TUP15060
C                                                                       TUP15070
      IF (IOPWPC .EQ. 0) GO TO 320                                      TUP15080
C                                                                       TUP15090
      WRITE(14) IYR,IDY,LH                                              TUP15100
      DO 320 NPT = 1,NPTLIM                                             TUP15110
         WRITE(14) HSAV(NPT),DSAV(NPT),(PARTC(NRE,NPT), NRE = 1,NRELIM) TUP15120
  320 CONTINUE                                                          TUP15130
C                                                                       TUP15140
C         KEEP TRACK OF NUMBER OF HOURS CALCULATED.  UPDATE MAXIMUM     TUP15150
C          CONCENTRATION.                                               TUP15160
C                                                                       TUP15170
      NTAH = NTAH + 1                                                   TUP15180
C         NTAH:   TOTAL NUMBER OF HOURS CALCULATED.                     TUP15190
      CALL TU335(IYR,IDY,LH,HMAX,IYRMAX,IDYMAX,LHMAX,MAXREC)            TUP15200
      IF (NTAH .GT.NPRNT) GO TO 500                                     TUP15210
      CALL TU340(IYR,IDY,LH,HSAV,DSAV)                                  TUP15220
      GO TO 500                                                         TUP15230
C                                                                       TUP15240
C         MISSING (MISG = 1) AND INCOMPLETE (MISG > 1) PROCESSING.      TUP15250
C                                                                       TUP15260
  400 MISG = 1                                                          TUP15270
C         WRITE HOURLY RECORD, WITH MISG CONC., TO UNIT 12.             TUP15280
  405 WRITE(12) IYR,IDY,LH                                              TUP15290
      WRITE(12) (DHDUM(NPT),NPT = 1,NPTLIM),(DHDUM(NPT),NPT = 1,NPTLIM) TUP15300
      WRITE(12) (CDUM(NRE), NRE = 1,NRELIM)                             TUP15310
      IF (MISG .GT. 1) GO TO 415                                        TUP15320
      WRITE(IO,1010) IYR,IDY,LH                                         TUP15330
      KMISS = KMISS + 1                                                 TUP15340
      GO TO 420                                                         TUP15350
  415 WRITE(IO,1015) IYR,IDY,LH                                         TUP15360
      KINCOM = KINCOM + 1                                               TUP15370
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  420 IF(IOPWPC .EQ. 0) GO TO 500                                       TUP15380
C         WRITE NPTLIM PARTIAL CONC. RECORDS, WITH MISG CONC., TO       TUP15390
C           UNIT 14.                                                    TUP15400
      WRITE(14) IYR,IDY,LH                                              TUP15410
      DO 430 NPT = 1,NPTLIM                                             TUP15420
         WRITE(14) DHDUM(NPT),DHDUM(NPT),(CDUM(NRE), NRE = 1,NRELIM)    TUP15430
  430 CONTINUE                                                          TUP15440
C                                                                       TUP15450
C         CHECK FOR END OF SIMULATION.                                  TUP15460
C                                                                       TUP15470
  500 NHR = NHR + 1                                                     TUP15480
C         NHR:  TOTAL NUMBER OF HOURS CONSIDERED.                       TUP15490
      IF (IHREX .NE. IHREND) GO TO 100                                  TUP15500
C                                                                       TUP15510
      WRITE(IO,1030) LINE1,LINE2,LINE3                                  TUP15520
      WRITE(IO,1040)                                                    TUP15530
      WRITE(IO,1050) NPOL,IYRS,IDYS,IHRS,IYR,IDY,LH                     TUP15540
      WRITE(IO,1060) HMAX,IYRMAX,IDYMAX,LHMAX,MAXREC                    TUP15550
      WRITE(IO,1070) KMISS,KINCOM,NTAH                                  TUP15560
      WRITE (IO,1080) (IHFC(I),I = 1,NPTLIM)
C                                                                       TUP15570
C         GET NEXT SIMULATION PERIOD.                                   TUP15580
C                                                                       TUP15590
      READ(IN,*,ERR=650,END=900) IYRS,IDYS,IHRS,IHLIM                   TUP15600
      GO TO 20                                                          TUP15610
C         ERROR ON READING NEW SIMULATION PERIOD.                       TUP15620
  650 ICOND = 22004                                                     TUP15630
      WRITE(IO,1020)                                                    TUP15640
C                                                                       TUP15650
C         RETURN SEQUENCE.                                              TUP15660
C                                                                       TUP15670
  900 ENDFILE 12                                                        TUP15680
      ENDFILE 12                                                        TUP15690
      IF (IOPWPC .EQ. 0) GO TO 999                                      TUP15700
      ENDFILE 14                                                        TUP15710
      ENDFILE 14                                                        TUP15720
  999 RETURN                                                            TUP15730
C                                                                       TUP15740
C         FORMAT STATEMENTS.                                            TUP15750
C                                                                       TUP15760
 1000 FORMAT('0*** ERROR READING MET FILE (UNIT 9).')                   TUP15770
 1010 FORMAT('0MET DATA FOR YEAR-DAY-HOUR,',I2,'-',I3,'-',I2,', ARE ',  TUP15780
     1       'MISSING.  NO CONCENTRATION CALCULATIONS MADE.')           TUP15790
 1015 FORMAT('0MET DATA FOR YEAR-DAY-HOUR,',I2,'-',I3,'-',I2,', ARE ',  TUP15800
     1       'INCOMPLETE.  NO CONCENTRATION CALCULATIONS MADE.')        TUP15810
 1020 FORMAT('0*** SYSTEM ERROR ON READING INPUT FOR NEXT SIMULATION ', TUP15820
     1         'PERIOD.')                                               TUP15830
 1030 FORMAT(1H1,'TITLE:  ',20A4,2(/,9X,20A4))                          TUP15840
 1040 FORMAT(1H0,23X,'* * * SIMULATION SUMMARY * * *')                  TUP15850
 1050 FORMAT('0MAXIMUM ',A4,'CONCENTRATION FOR THE PERIOD (YR,DAY,HR) ',TUP15860
     1         I2,'-',I3,'-',I2,' TO ',I2,'-',I3,'-',I2)                TUP15870
 1060 FORMAT(' CONCENTRATION:',6PF10.2,/,                               TUP15880
     1       ' DATE:          ',I2,'-',I3,'-',I2,/,                     TUP15890
     2       ' RECEPTOR NUMBER:  ',I6,//)                              TUP15900
 1070 FORMAT('0NUMBER OF HOURLY MET RECORDS MISSING:      ',I6,/,       TUP15910
     1       ' NUMBER OF HOURLY MET RECORDS INCOMPLETE:  ',I6,/,       TUP15920
     2       ' CONCENTRATION ESTIMATES WERE MADE FOR:    ',I6,' HRS')   TUP15930
 1080 FORMAT ('0NUMBER OF HOURS OF HESITANT PLUME CALCULATIONS FOR EACH
     1SOURCE FOR THIS RUN.',/,10I10)
      END                                                               TUP15940
C
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      SUBROUTINE TU330(HSAV,DSAV,MISG)                                  TUP18130
C        330-CALCULATE-CONCENTRATION                                    TUP18140
C                                                                       TUP18150
C        ARGUMENT LIST:                                                 TUP18160
C          OUTPUT:  HSAV  - PLUME HEIGHTS FOR THIS HOUR (METERS)        TUP18170
C                   DSAV  - DISTANCE TO FINAL RISE FOR THIS HOUR        TUP18180
C                   MISG  - MISSING CODE (1 = MISSING)                  TUP18190
C                                                                       TUP18200
C        CALLING ROUTINES:                                              TUP18210
C          TU220                                                        TUP18220
C                                                                       TUP18230
C        SUBPROGRAMS CALLED:                                            TUP18240
C          TU435, TU440, TU445, TU450, TU455, ZF                        TUP18250
C                                                                       TUP18260
C        DESCRIPTION:                                                   TUP18270
C          THIS MODULE COORDINATES THE CONCENTRATION CALCULATIONS WHICH TUP18280
C          INCLUDES:                                                    TUP18290
C          -  CALCULATING PLUME RISE FOR EACH POINT SOURCE,             TUP18300
C          -  CALCULATING PLUME PENETRATION FOR EACH POINT SOURCE,      TUP18310
C          -  DETERMINING THE METEOROLOGY AT THE EFFECTIVE PLUME        TUP18320
C              HEIGHT FOR EACH POINT SOURCE,                            TUP18330
C          -  CALCULATING THE DISPERSION PARAMETERS AT EACH             TUP18340
C              RECEPTOR, AND                                            TUP18350
C          -  COMPUTING RELATIVE CONCENTRATIONS AT EACH RECEPTOR.       TUP18360
C                                                                       TUP18370
C         DEFINITIONS OF IMPORTANT VARIABLES:                           TUP18380
C                                                                       TUP18390
C         PARTC - HOURLY PARTIAL CONCENTRATION ARRAY.  CONTRIBUTIONS    TUP18400
C                 (G/M**3) BY RECEPTOR AND SOURCE.                      TUP18410
C         PHCHI - HOURLY CONCENTRATION ARRAY.  TOTAL CONCENTRATIONS     TUP18420
C                 (G/M**3) BY RECEPTOR.                                 TUP18430
C                                                                       TUP18440
      PARAMETER (NLMAX=20,NPTMAX=25,NREMAX=180,NDMAX=40)                TUP18450
      DIMENSION HSAV(NPTMAX),DSAV(NPTMAX)                               TUP18460
      COMMON /RUNCOM/CEILM,CONTWO,CTER,HAFL,TLOS,CONTER(4),IYRS,IDYS,   TUP18470
     1               IHRS,IHLIM,IOPT,IOPB,IOPD,IOPG,IOPM,IOPQ,IOPR,     TUP18480
     2               IOPWPC,NPOL,LINE1(20),LINE2(20),LINE3(20),NPRNT    TUP18490
      COMMON /METCOM/DTHDZ(NLMAX),SAL(NLMAX),SEL(NLMAX),TL(NLMAX),      TUP08120
     1               UL(NLMAX),WDL(NLMAX),ZL(NLMAX),KLASS,LMX,MDATA,    TUP08130
     2               MDATB,METNAM(2),MYR,MJD,MHR,ND,NLLIM,
     3               DESC(18,NDMAX),NFLG(NLMAX)
      COMMON /HEST/ HSTAR,WSTAR,FSTAR
      COMMON /SORCOM/D(NPTMAX),PNAME(3,NPTMAX),PSH(NPTMAX),QJ(NPTMAX),  TUP18530
     1               QELEV(NPTMAX),QEAST(NPTMAX),QNORD(NPTMAX),         TUP18540
     2               TS(NPTMAX),VS(NPTMAX),IQYR,IQJD,IQHR,NPTLIM,       TUP18550
     3               IMPS(NPTMAX)                                       TUP18560
      COMMON /RECCOM/ELR(NREMAX),PARTC(NREMAX,NPTMAX),PHCHI(NREMAX),    TUP18570
     1               RNAME(2,NREMAX),RREC(NREMAX),SREC(NREMAX),         TUP18580
     2               STAR(2,NREMAX),ZR(NREMAX),NRELIM                   TUP18590
      COMMON /HESFLG/ IHFC(NPTMAX)
C         INITIALIZE LAYER FLAGS FOR THIS HOUR.
C                                                                       TUP18620
      DO 5 NL = 1,NLLIM                                                 TUP18630
         NFLG(NL) = 0
    5 CONTINUE                                                          TUP18650
C                                                                       TUP18660
C         BEGIN LOOP OVER SOURCES.                                      TUP18670
C                                                                       TUP18680
      DO 300 NPT = 1,NPTLIM                                             TUP18690
C                                                                       TUP18700
C         CALCULATE PLUME RISE AND PENETRATION.
C                                                                       TUP18720
      CALL TU435(NPT,HL,H,FO,UST,DELHPR,HEPR,DISTF,PORT,ZMN,PDH,MISG)
      IF (MISG .GT. 0) GO TO 999                                        TUP18740
C                                                                       TUP18750
      IF (PORT .GT. 0.) GO TO 20                                        TUP18790
C                                                                       TUP18800
C         NONE OF PLUME AVAILABLE FOR MIXING.                           TUP18810
C                                                                       TUP18820
      IF (IOPWPC .EQ. 0) GO TO 300                                      TUP18830
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      DO 10 NRE = 1,NRELIM                                              TUP18840
         PARTC(NRE,NPT) = 0.0                                           TUP18850
   10 CONTINUE                                                          TUP18860
      GO TO 300                                                         TUP18870
C                                                                       TUP18880
C        CALCULATE EMISSIONS METEOROLOGY.                               TUP18890
C                                                                       TUP18900
   20 CALL TU445(HEPR,UPL,WDPL,SAPL,SEPL,MISG)                          TUP18910
      IF (MISG .GT. 0) GO TO 999                                        TUP18920
C                                                                       TUP18930
C        CALCULATE DISTANCE TO FINAL RISE.                              TUP18940
C                                                                       TUP18950
      IF (DISTF .EQ. 0) GO TO 25                                        TUP18960
      DISTF = (DELHPR * UST/(160. * FO ** 0.333333)) ** 1.5             TUP18970
C                                                                       TUP18980
C        SET SOURCE PARAMETERS.                                         TUP18990
C                                                                       TUP19000
   25 Q = QJ(NPT) * PORT                                                TUP19010
      RQ = QEAST(NPT)                                                   TUP19020
      SQ = QNORD(NPT)                                                   TUP19030
      EP = QELEV(NPT)                                                   TUP19040
      HSAV(NPT) = HEPR                                                  TUP19050
      DSAV(NPT) = DISTF                                                 TUP19060
      TRAD = WDPL * 0.017453292                                         TUP19070
      SINT = SIN(TRAD)                                                  TUP19080
      COST = COS(TRAD)                                                  TUP19090
C                                                                       TUP19100
      IF (HSTAR.LE.0.001) GO TO 27
      IF (FSTAR.LE.0.09) GO TO 27
      IF (WSTAR.LT.0.) GO TO 27
C
C        CONCENTRATION CALCULATIONS - HESITANT PLUME
C
      PARSY = 1.6 * FO ** 0.333333/UPL
      PCN = 7.0 * FO/WSTAR ** 3.
      PCD = 2.507 * UPL * HL
C
      DO 400 NRE = 1,NRELIM
      XDUM = RQ - RREC(NRE)
      YDUM = SQ - SREC(NRE)
      X = (YDUM * COST + XDUM * SINT) * CONTWO
      IF (X.LE.0.) GO TO 400
      Y = (YDUM * SINT - XDUM * COST) * CONTWO
      XM = 1000. * X
      SY = PARSY * XM ** 0.666667
      IF (SY.GT.0.8 * XM) SY = 0.8 * XM
      RC = EXP (-1.0 * (PCN/XM) ** 1.5)/(PCD * SY)
      YM = 1000. * Y
      RC = RC * PWR (YM,SY)
      TT = X/UPL
      PROD = RC * Q/EXP(TT * TLOS)
      PHCHI(NRE) = PHCHI(NRE) + PROD
      PARTC(NRE,NPT) = PROD
  400 CONTINUE
C        END OF LOOP FOR RECEPTORS
      IHFC(NPT) = IHFC(NPT) + 1
      GO TO 300
   27 IF (IOPT.EQ.0) GO TO 110
C                                                                       TUP19120
C        CONCENTRATION CALCULATIONS -- TERRAIN CASE.                    TUP19130
C                                                                       TUP19140
      DO 100 NRE = 1,NRELIM                                             TUP19150
C        BEGIN LOOP OVER RECEPTORS.                                     TUP19160
      HTEMP = HEPR                                                      TUP19170
C        INITIALIZING HTEMP AGAIN IN CASE MODIFIED BY TERRAIN OR        TUP19180
C         GRADUAL RISE.                                                 TUP19190
      PARTC(NRE,NPT) = 0.0                                              TUP19200
      ER = ELR(NRE)                                                     TUP19210
      Z = ZR(NRE)                                                       TUP19220
      IF (KLASS .EQ. 4) GO TO 30                                        TUP19230
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      IF (Z .GT. HL) GO TO 100                                          TUP19240
   30 XDUM = RQ - RREC(NRE)                                             TUP19250
      YDUM = SQ - SREC(NRE)                                             TUP19260
      X = (YDUM * COST + XDUM * SINT) * CONTWO                          TUP19270
      IF (X .LE. 0.) GO TO 100                                          TUP19280
      Y = (YDUM * SINT - XDUM * COST) * CONTWO                          TUP19290
      DELH = DELHPR                                                     TUP19300
C         MUST RESET PLUME RISE HERE SINCE MAY HAVE MODIFIED (FOURTH    TUP19310
C         EXECUTABLE STATEMENT DOWN) FOR LAST RECEPTOR.                 TUP19320
      IF (X .GE. DISTF) GO TO 50                                        TUP19330
      IF ((IOPB .EQ. 0) .AND. (IOPG .EQ. 1)) GO TO 50                   TUP19340
C         RECALCULATE PLUME RISE IF EITHER GRADUAL RISE OR BID.         TUP19350
      DLHG = PDH * X ** 0.666667                                        TUP19370
      IF (DELH .GT. DLHG) DELH = DLHG                                   TUP19380
      IF (IOPG .EQ. 1) GO TO 50                                         TUP19390
C         MODIFY PLUME HEIGHT ONLY IF USING GRADUAL RISE.               TUP19400
      HTEMP = H + DELH                                                  TUP19410
      ZMN = HTEMP                                                       TUP19420
      IF (KLASS .GT. 2) GO TO 50                                        TUP19430
      IF (HL - HTEMP .LT. ZMN) ZMN = HL - HTEMP                         TUP19440
C         MODIFY H FOR TERRAIN.                                         TUP19450
   50 DUM = ER - EP                                                     TUP19460
      HTEMP = HTEMP + CEIM * (CTER * DUM - DUM)                         TUP19470
      RC = 0.0                                                          TUP19480
      IF (X .LT. 0.001) GO TO 60                                        TUP19490
      IF (HTEMP.LT.0.) HTEMP = 0.                                       TUP19500
C                                                                       TUP19510
C         CALCULATE DISPERSION PARAMETERS.                              TUP19520
C                                                                       TUP19530
      CALL TU450(X,UPL,SAPL,SEPL,DELH,SY,SZ)                            TUP19540
C                                                                       TUP19550
C         CALCULATE RELATIVE CONCENTRATION.                             TUP19560
C                                                                       TUP19570
      CALL TU455(Y,Z,HTEMP,SY,SZ,HL,UST,RC)                             TUP19580
      DA = SZ/ZMN                                                       TUP19590
      Z = ZF(DA) * ZMN                                                  TUP19600
      CALL TU455(Y,Z,ZMN,SY,SZ,HL,UST,RCT)                              TUP19610
      IF (RCT .LT. RC) RC = RCT                                         TUP19620
C                                                                       TUP19630
C         CALCULATE ABSOLUTE CONCENTRATION.  INCLUDE EXPONENTIAL        TUP19640
C          POLLUTANT LOSS.  UNITS OF CONCENTRATION ARE G/M**3.          TUP19650
C                                                                       TUP19660
   60 TT = X/UPL                                                        TUP19670
C          TT:  TRAVEL TIME IN SEC-KM/M.                                TUP19680
      PROD = RC * Q/EXP(TT * TLOS)                                      TUP19690
      PHCHI(NRE) = PHCHI(NRE) + PROD                                    TUP19700
      PARTC(NRE,NPT) = PROD                                             TUP19710
  100 CONTINUE                                                          TUP19720
C         END OF LOOP FOR RECEPTORS.                                    TUP19730
      GO TO 300                                                         TUP19740
C                                                                       TUP19750
C         CONCENTRATION CALCULATIONS — NO TERRAIN.                      TUP19760
C                                                                       TUP19770
  110 DO 200 NRE = 1,NRELIM                                             TUP19780
C         BEGIN LOOP OVER RECEPTORS.                                    TUP19790
      HTEMP = HEPR                                                      TUP19800
C         INITIALIZING HTEMP AGAIN IN CASE MODIFIED BY GRADUAL RISE.    TUP19810
      PARTC(NRE,NPT) = 0.0                                              TUP19820
      Z = ZR(NRE)                                                       TUP19830
      IF (KLASS .EQ. 4) GO TO 130                                       TUP19840
      IF (Z .GT. HL) GO TO 200                                          TUP19850
  130 XDUM = RQ - RREC(NRE)                                             TUP19860
      YDUM = SQ - SREC(NRE)                                             TUP19870
      X = (YDUM * COST + XDUM * SINT) * CONTWO                          TUP19880
      IF (X .LE. 0.) GO TO 200                                          TUP19890
      Y = (YDUM * SINT - XDUM * COST) * CONTWO                          TUP19900
      DELH = DELHPR                                                     TUP19910
C         MUST RESET PLUME RISE HERE SINCE MAY HAVE MODIFIED (FOURTH    TUP19920
C         EXECUTABLE STATEMENT DOWN) FOR LAST RECEPTOR.                 TUP19930
      IF (X .GE. DISTF) GO TO 150
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      IF ((IOPB .EQ. 0) .AND. (IOPG .EQ. 1)) GO TO 150                  TUP19940
C         RECALCULATE PLUME RISE IF EITHER GRADUAL RISE OR BID.         TUP19950
      DLHG = PDH * X ** 0.666667
      IF (DELH .GT. DLHG) DELH = DLHG                                   TUP19970
      IF (IOPG .EQ. 1) GO TO 150                                        TUP19980
C         MODIFY PLUME HEIGHT ONLY IF USING GRADUAL RISE.               TUP19990
      HTEMP = H + DELH                                                  TUP20000
  150 RC = 0.0                                                          TUP20010
      IF (X .LT. 0.001) GO TO 160                                       TUP20020
C                                                                       TUP20030
C         CALCULATE DISPERSION PARAMETERS.                              TUP20040
C                                                                       TUP20050
      CALL TU450(X,UPL,SAPL,SEPL,DELH,SY,SZ)                            TUP20060
C                                                                       TUP20070
C         CALCULATE RELATIVE CONCENTRATION.                             TUP20080
C                                                                       TUP20090
      CALL TU455(Y,Z,HTEMP,SY,SZ,HL,UST,RC)                             TUP20100
C                                                                       TUP20110
C         CALCULATE ABSOLUTE CONCENTRATION.  INCLUDE EXPONENTIAL        TUP20120
C          POLLUTANT LOSS.  UNITS OF CONCENTRATION ARE G/M**3.          TUP20130
C                                                                       TUP20140
  160 TT = X/UPL                                                        TUP20150
C         TT:  TRAVEL TIME IN SEC-KM/M.                                 TUP20160
      PROD = RC * Q/EXP(TT * TLOS)                                      TUP20170
      PHCHI(NRE) = PHCHI(NRE) + PROD                                    TUP20180
      PARTC(NRE,NPT) = PROD                                             TUP20190
  200 CONTINUE                                                          TUP20200
C         END OF LOOP FOR RECEPTORS.                                    TUP20210
  300 CONTINUE                                                          TUP20220
C         END OF LOOP FOR SOURCES.                                      TUP20230
  999 RETURN                                                            TUP20240
      END                                                               TUP20250
C
      FUNCTION PWR(A,SIG)
      PWR = 0.
      DUM = A/SIG
      IF (ABS(DUM).GE.6) RETURN
      PWR = 1./EXP(0.5 * DUM * DUM)
      RETURN
      END
C
      SUBROUTINE TU435(NPT,HL,H,FO,UST,DELHPR,HEPR,DISTF,PORT,ZMN,PDH,
     1 MISG)
C        435-LAYER-BY-LAYER-PLUME-RISE AND PENETRATION.
C                                                                       TUP20280
C        ARGUMENT LIST:                                                 TUP20290
C          INPUT:    NPT    - SOURCE NUMBER                            TUP20300
C          OUTPUT:   HL     - MIXING HEIGHT (METERS)                   TUP20310
C                    H      - PHYSICAL STACK HEIGHT (METERS)           TUP20320
C                    FO     - INITIAL BUOYANCY FLUX (M**4/S**3)
C                    UST    - WIND SPEED AT STACK TOP (M/SEC)
C                    DELHPR - PLUME RISE (METERS)
C                    HEPR   - EFFECTIVE PLUME HEIGHT (METERS)
C                    DISTF  - DISTANCE TO FINAL RISE
C                    PORT   - PORTION OF PLUME BENEATH THE MIXING HEIGHT
C                    ZMN    - MINIMUM DISTANCE BETWEEN THE EFFECTIVE
C                              PLUME HEIGHT AND A BOUNDING SURFACE
C                    PDH    - PARTIAL PLUME RISE CALCULATION
C                    MISG   - MISSING CODE (IF MISG > 0 THEN MISSING)   TUP20410
C                                                                       TUP20420
C        CALLING ROUTINES:                                              TUP20430
C          TU330                                                        TUP20440
C                                                                       TUP20450
C        SUBPROGRAM CALLED:                                             TUP20460
C          TU510
C                                                                       TUP20480
C        DESCRIPTION:                                                   TUP20490
C          PLUME RISE IS CALCULATED THROUGH EACH VERTICAL LAYER TAKING  TUP20500
C          INTO ACCOUNT THE VARIATION OF METEOROLOGICAL INFORMATION     TUP20510
C          WITH HEIGHT (SPECIFICALLY, TEMPERATURE AND WIND SPEED).  IT  TUP20520
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C          IS ASSUMED THAT THE METEOROLOGICAL INFORMATION IS SUFFI-      TUP20530
C          CIENTLY DENSE IN THE VERTICAL SO THAT LINEAR INTERPOLATION    TUP20540
C          OF THE PARAMETERS BETWEEN LEVELS YIELDS REASONABLE VALUES.    TUP20550
C                                                                        TUP20560
      PARAMETER (NLMAX=20,NPTMAX=25,NDMAX=40)                            TUP20570
      DIMENSION ZTOP(NLMAX)                                              TUP20580
      COMMON /RUNCOM/CELM,CONTWO,CTER,HAFL,TLOS,CONTER(4),IYRS,IDYS,     TUP20590
     1               IHRS,IHLIM,IOPT,IOPB,IOPD,IOPG,IOPM,IOPQ,IOPR,      TUP20600
     2               IOPWPC,NPOL,LINE1(20),LINE2(20),LINE3(20),NPRNT     TUP20610
      COMMON /METCOM/DTHDZ(NLMAX),SAL(NLMAX),SEL(NLMAX),TL(NLMAX),       TUP08120
     1               UL(NLMAX),WDL(NLMAX),ZL(NLMAX),KLASS,LMX,MDATA,     TUP08130
     2               MDATB,METNAM(2),MYR,MJD,MHR,ND,NLLIM,
     3               DESC(18,NDMAX),NFLG(NLMAX)
      COMMON /HEST/ HSTAR,WSTAR,FSTAR
      COMMON /SORCOM/D(NPTMAX),PNAME(3,NPTMAX),PSH(NPTMAX),QJ(NPTMAX),   TUP20650
     1               QELEV(NPTMAX),QEAST(NPTMAX),QNORD(NPTMAX),          TUP20660
     2               TS(NPTMAX),VS(NPTMAX),IQYR,IQJD,IQHR,NPTLIM,        TUP20670
     3               IMPS(NPTMAX)                                        TUP20680
      COMMON /METLYR/UBOT,TBOT,UTOP,TTOP,UBAR(NLMAX),TBAR(NLMAX)
      DATA AMISG/-9999./                                                 TUP20690
C         INITIALIZE.                                                    TUP20710
      MISG = 0                                                           TUP20730
      PDH = 0.
      DISTF = 0.
      IDUM = 10
      HL = ZL(LMX)                                                       TUP20780
      H = PSH(NPT)                                                       TUP20790
      IRCNT = 1
C         FIND HEIGHT ABOVE STACK TOP OF EACH LEVEL.                     TUP20810
      DO 20 NL = 1,NLLIM                                                 TUP20830
   20    ZTOP(NL) = ZL(NL) - H                                           TUP20840
C            ZTOP IS VERTICAL DISTANCE OF DATA LEVEL ABOVE STACK HEIGHT.
      IF (H .LT. ZL(NLLIM)) GO TO 40                                     TUP20880
C         STACK HEIGHT GREATER THAN TOP LEVEL.
      IF (NFLG(NLLIM).EQ.1) GO TO 30
      IBOT = NLLIM - 1
      IF (NFLG(IBOT).EQ.0) CALL TU510(IBOT,MISG)
      IDUM = 20
      IF (NFLG(IBOT).NE.1) GO TO 900
      NFLG(NLLIM) = 1
      UBAR(NLLIM) = UL(NLLIM)
      TBAR(NLLIM) = TL(NLLIM)
      DTHDZ(NLLIM) = DTHDZ(IBOT)
   30 IBOT = NLLIM
      IRPT = 2
      U = UBAR(NLLIM)
      T = TBAR(NLLIM)
      THZ = DTHDZ(NLLIM)
      GO TO 100
C         STACK HEIGHT LESS THAN TOP LEVEL.
   40 IF (H.GT.ZL(1)) GO TO 50
C         STACK HEIGHT LESS THAN FIRST LEVEL.
      IBOT = 1
      IRPT = 2
      IF (NFLG(1).EQ.0) CALL TU510(IBOT,MISG)
      IDUM = 40
      IF (NFLG(1).NE.1) GO TO 900
      IBOT = 0
      U = UL(1)
      T = TL(1)
      THZ = DTHDZ(1)
      GO TO 100
C         STACK HEIGHT BETWEEN BOTTOM AND TOP LEVELS.
   50 NL = 0
   60 NL = NL + 1
      IF (ZTOP(NL).LE.0.) GO TO 60
      IBOT = NL - 1
      IRPT = 1
      ZLYR = ZL(NL) - ZL(IBOT)
      FRACT = (H-ZL(IBOT))/ZLYR
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      IF (NFLG(IBOT).EQ.0) CALL TU510(IBOT,MISG)
      IDUM = 60
      IF (NFLG(IBOT).NE.1) GO TO 900
      U = UBOT + FRACT * (UTOP - UBOT)
      T = TBOT + FRACT * (TTOP - TBOT)
      THZ = DTHDZ(IBOT)
C        STACK TOP WINDS AND TEMPERATURE ARE IN U AND T.
  100 UST = U
      FTIP = 1.
      IF (IOPD.EQ.1) GO TO 140
C        CALCULATE STACK-TIP DOWNWASH CORRECTION FACTOR.
C           CALCULATE FROUDE NUMBER.
      FR = VS(NPT) * VS(NPT)/(9.806 * D(NPT) * (TS(NPT) - T)/T)
      IF (FR.LT.3) GO TO 140
      IF (U.LE.VS(NPT)/1.5) GO TO 140
      IF (U.GE.VS(NPT)) GO TO 120
C
      FTIP = 3. * (VS(NPT) - U)/VS(NPT)
      GO TO 130
  120 FTIP = 0.
  130 IF (FTIP.GT.0.) GO TO 140
      DELH = 0.
      PORT = 1.
      GO TO 320
C
C          DETERMINE INITIAL BUOYANCY FLUX.
C
  140 FO = 9.806*VS(NPT)*D(NPT)*D(NPT)*(TS(NPT)-T)/(4.*TS(NPT))
C           STATEMENTS FOR 435
      IF (WSTAR.EQ.AMISG) THEN
      FSTAR = AMISG
      ELSE
      FSTAR = FO/(UST * WSTAR ** 2. * HL)
      END IF
      F = FO
      FO3 = FO ** 0.333333
C
      ZB = 0.
C        CALCULATE UNSTABLE-NEUTRAL MOMENTUM RISE FOR LATER COMPARISON.
      DHUM = 3. * D(NPT) * VS(NPT)/U
C
C        BEGINNING POINT TO DETERMINE RISE THROUGH EACH LAYER.
  145 IF (THZ.GT.0.001) GO TO 250
C
C        DETERMINE PLUME RISE (DELH) THROUGH UNSTABLE-NEUTRAL LAYER.
  150 DHL = 30. * (F/U) ** 0.6 + ZB
      FOU3 = F/U ** 3.
      DELH = 24. * FOU3 ** 0.6 * (H + 200. * FOU3) ** 0.4 + ZB
      IEQ = 6
      IF (DELH.GT.DHL) THEN
      DELH = DHL
      IEQ = 5
      END IF
      IF (DELH.GT.DHUM) GO TO 160
      DELH = DHUM
      GO TO 310
  160 IF (IBOT.EQ.NLLIM) GO TO 310
      IF (DELH.GT.ZTOP(IBOT +1)) GO TO 200
C          PLUME CENTERLINE IS BELOW TOP OF LAYER.
  170 DELT = 1.5 * DELH
      DELB = 0.5 * DELH
C          CHECK FOR PLUME TOP INTO STABLE LAYER.
  180 IF (DELT.LT.ZTOP(IBOT + 1)) GO TO 310
C          PLUME TOP IS ABOVE TOP OF LAYER.
      IBOT = IBOT + 1
      ZB = ZTOP(IBOT)
      IF (NFLG(IBOT).EQ.0) CALL TU510(IBOT,MISG)
      IDUM = 180
      IF (NFLG(IBOT).NE.1) GO TO 900
      THZ = DTHDZ(IBOT)
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      IF (THZ.GT.0.001) GO TO 190
      GO TO 180
  190 FUS = (FO * T/(U * 9.806 * THZ)) ** 0.333333
      P = (3.9 - ZB/FUS)/2.6
      IF (P.LT.0.) P = 0.
      IF (P.GT.1.) P = 1.
      DELH = FTIP * DELH
      DELH = (ZB + 0.5 * DELH)/2.
      PORT = 1. - P
      GO TO 320
C         DELH EXTENDS ABOVE TOP OF THIS LAYER.
  200 IF (IRPT.NE.1) GO TO 210
C         NEED TO REPEAT CALC FOR LAYER MEANS.
      IRCNT = IRCNT + 1
      IRPT = 2
      U = (U + UL(IBOT+1))/2.
      T = (T + TL(IBOT+1))/2.
      GO TO 150
  210 ZT = ZTOP(IBOT + 1)
C         DETERMINE UNSTABLE-NEUTRAL RESIDUAL BUOYANCY.
      IF (IEQ.EQ.5) THEN
C         DELH WAS CALCULATED USING EQ (5).
      FR = U * ((DELH -  ZT)/30.) ** 1.66667
      ELSE
C         DELH WAS CALCULATED USING EQ (6).
      DUM = DELH - ZT
      FR = 0.0055 * DUM * U ** 3./(1. + H/DUM) ** 0.666667
      END IF
      F = FR
      IF (F.GT.0.) GO TO 240
      DELH = ZT
      GO TO 310
C
C         DETERMINE PLUME RISE THROUGH A STABLE LAYER BY DETERMINING
C          HEIGHT OF PLUME TOP (DELT).
  250 IF (IRCNT.GT.1) GO TO 260
      DHSM = 0.646 * (VS(NPT) * VS(NPT) * D(NPT) * D(NPT)/
     1 (TS(NPT) * U)) ** 0.333333 * SQRT(T)/THZ ** 0.166667
      IF (DHUM.LT.DHSM) DHSM = DHUM
C         STABLE MOMENTUM RISE IS SMALLER OF DHUM AND DHSM.
C
C         CALCULATE STABLE BUOYANCY RISE.
  260 DELT = (1.8 * F * T/(U * THZ) + ZB ** 3.) ** 0.333333
      IEQ = 10
      DHTL = (4.1 * F * T/(FO3 * THZ) + ZB ** 2.66667) ** 0.375
C         STABLE BUOYANCY RISE IS SMALLER OF DELT AND DHTL
      IF (DHTL.LT.DELT) THEN
      DELT = DHTL
      IEQ = 11
      END IF
  270 IF (IRCNT.GT.1) GO TO 280
C         IF STABLE MOMENTUM RISE IS LARGER THAN BUOYANCY RISE,
C          SUBSTITUTE.
      DELH = 0.666667 * DELT
      IF (DELH.GT.DHSM) GO TO 280
      DELH = DHSM
      GO TO 310
  280 IF (IBOT.EQ.NLLIM) GO TO 285
      ZT = ZTOP(IBOT + 1)
      IF (DELT.GT.ZT) GO TO 290
  285 DELH = 0.666667 * DELT
C         PLUME RISE IS 2/3 DISTANCE TO PLUME TOP.
C          ASSUMES PLUME THICKNESS EQUALS RISE.
      GO TO 310
C         PLUME TOP EXTENDS INTO NEXT LAYER.
  290 IF (IRPT.NE.1) GO TO 300
C         GO BACK AND CALCULATE AGAIN USING MEAN WIND AND MEAN TEMP.
      IRCNT = IRCNT + 1
      IRPT = 2
      U = (U + UL(IBOT+1))/2.
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      T = (T + TL(IBOT+1))/2.
      GO TO 260
C        DETERMINE STABLE RESIDUAL BUOYANCY.
  300 IF (IEQ.EQ.10) THEN
C        DELT WAS CALCULATED USING EQ (10).
      FR = F - 0.56 * THZ * U/T * (ZT ** 3. - ZB ** 3.)
      ELSE
C        DELT WAS CALCULATED USING EA (11).
      FR = F - 0.24 * THZ * FO3/T * (ZT ** 2.66667 - ZB ** 2.66667)
      END IF
      F = FR
      IF (F.GT.0.) GO TO 240
      DELT = ZT
      DELH = 0.666667 * DELT
      GO TO 310
C
C        DETERMINE CONDITIONS FOR NEXT LAYER.
  240 IBOT = IBOT + 1
      ZB = ZTOP(IBOT)
      IF (NFLG(IBOT).EQ.0) CALL TU510(IBOT,MISG)
      IDUM = 240
      IF(NFLG(IBOT).NE.1) GO TO 900
      U = UBAR(IBOT)
      T = TBAR(IBOT)
      THZ = DTHDZ(IBOT)
      GO TO 145
C
C        DETERMINE PENETRATION.
  310 PORT = 1.
      DELH = FTIP * DELH
      HE = H + DELH
      DELT = HE + 0.5 * DELH
      DELB = HE - 0.5 * DELH
      IF (KLASS.LT.3) GO TO 312
C         NIGHTTIME
      IF (IOPM.EQ.0) GO TO 320
      IF (DELB.LT.HL) GO TO 320
      GO TO 318
C         DAYTIME
  312 IF (DELT.LT.HL) GO TO 320
      IF (DELB.GT.HL) GO TO 318
C         PLUME TOP GREATER THAN MIXING HEIGHT.
      HE = (HL + DELB)/2.
      PORT = (HL - DELB)/DELH
      DELH = HE - H
      GO TO 320
  318 PORT = 0.
  320 HE = H + DELH
      ZMN = HE
      DUM = HL - HE
      IF (DUM.LT.ZMN) ZMN = DUM
      HEPR = HE
      DELHPR = DELH
C        PARTIAL DELH CALCULATION
      IF (DELH.EQ.0.) GO TO 999
      PDH = 160. * FO3/UST
      DISTF = (DELH/PDH) ** 1.5
      GO TO 999
  900 MISG = IDUM
  999 RETURN
      END
C
      SUBROUTINE TU510(IBOT,MISG)
C        510-OBTAIN DATA FOR A LAYER.
C                                                                      TUP23400
C        ARGUMENT LIST:                                                TUP23410
C          INPUT:    IBOT - NUMBER OF BOTTOM LEVEL OF LAYER           TUP23420
C                    NFLG - ARRAY OF FLAGS.
C          OUTPUT:   MISG - MISSING INDICATOR (POSITIVE = MISSING)
C                                                                      TUP23450
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C         CALLING ROUTINES:                                                    TUP23460
C           TU435                                                              TUP23470
C                                                                              TUP23480
C         DESCRIPTION:                                                         TUP23490
C           THIS SUBROUTINE CALCULATES THE METEOROLOGICAL PARAMETER
C            VALUES FOR A LAYER.
C                                                                              TUP23520
      PARAMETER (NLMAX=20,NDMAX=40)                                            TUP23530
      COMMON /METCOM/DTHDZ(NLMAX),SAL(NLMAX),SEL(NLMAX),TL(NLMAX),             TUP08120
     1               UL(NLMAX),WDL(NLMAX),ZL(NLMAX),KLASS,LMX,MDATA,           TUP08130
     2               MDATB,METNAM(2),MYR,MJD,MHR,ND,NLLIM,
     3               DESC(18,NDMAX),NFLG(NLMAX)
      COMMON /HEST/ HSTAR,WSTAR,FSTAR
      COMMON /METLYR/UBOT,TBOT,UTOP,TTOP,UBAR(NLMAX),TBAR(NLMAX)
      DATA AMISG/-9999./                                                       TUP23570
C                                                                              TUP23580
      NFLG(IBOT) = 1
      UBOT = UL(IBOT)
      TBOT = TL(IBOT)
      IF (UBOT.EQ.AMISG) GO TO 990
      IF (TBOT.EQ.AMISG) GO TO 990
      ITOP = IBOT + 1
      UTOP = UL(ITOP)
      TTOP = TL(ITOP)
      IF (UTOP.EQ.AMISG) GO TO 990
      IF (TTOP.EQ.AMISG) GO TO 990
      UBAR(IBOT) = (UBOT + UTOP)/2.
      TBAR(IBOT) = (TBOT + TTOP)/2.
      DTHDZ(IBOT) = (TTOP - TBOT)/(ZL(ITOP) - ZL(IBOT)) + 0.0098
      GO TO 999
  990 NFLG(IBOT) = -1
      MISG = 510
C
  999 RETURN
      END

      SUBROUTINE CHRON(IYR,IJD,IHR,IYDH)                                       TUP31740
C         CHRON-CONVERT-DATE                                                   TUP31750
C                                                                              TUP31760
C         ARGUMENT LIST:                                                       TUP31770
C           INPUT:    IYR  - YEAR (2 DIGITS)                                   TUP31780
C                     IJD  - JULIAN DAY (3 DIGITS)                             TUP31790
C                     IHR  - HOUR (2 DIGITS)                                   TUP31800
C           OUTPUT:   IYDH - DATE CONVERTED TO HOUR                            TUP31810
C                                                                              TUP31820
C         CALLING ROUTINES:                                                    TUP31830
C           TU220, TU320, TU325                                                TUP31840
C                                                                              TUP31850
C         DESCRIPTION:                                                         TUP31860
C           THIS SUBROUTINE CONVERTS DATES BETWEEN 1960 AND 1999 TO A          TUP31870
C           COMMON SEQUENTIAL HOUR.  THE ZERO POINT IS 1959, 365, 24,          TUP31880
C           I.E., HOUR 1 IS THE FIRST HOUR OF 1960.                            TUP31890
C                                                                              TUP31900
      DIMENSION ICUM(41),NDAY(40)                                              TUP31910
      COMMON /INOUT/ IN,IO                                                     TUP31920
      DATA ICUM/      0,  8784, 17544, 26304, 35064, 43848, 52608,             TUP31930
     1            61368, 70128, 78912, 87672, 96432,105192,113976,             TUP31940
     2           122736,131496,140256,149040,157800,166560,175320,             TUP31950
     3           184104,192864,201624,2103[illegible] 219168,227928,236688,    TUP31960
     4           245448,254232,262992,27178[illegible] 280512,289296,298056,    TUP31970
     5           306816,315576,324360,333120,341880,350640/                    TUP31980
      DATA NDAY/366,365,365,365,                                               TUP31990
     1          366,365,365,365,                                               TUP32000
     2          366,365,365,365,                                               TUP32010
     3          366,365,365,365,                                               TUP32020
     4          366,365,365,365,                                               TUP32030
     5          366,365,365,365,                                               TUP32040
     6          366,365,365,365,                                               TUP32050
     7          366,365,365,365,                                               TUP32060
     8          366,365,365,365,                                               TUP32070
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     9          366,365,365,365/                                        TUP32080
      DATA IZPT/59/                                                     TUP32090
C                                                                       TUP32100
C         SCREEN INPUT.                                                 TUP32110
C                                                                       TUP32120
      IF ((IYR .GT. 59) .AND. (IYR .LT. 100)) GO TO 100                 TUP32130
      WRITE(IO,1000) IYR                                                TUP32140
      GO TO 990                                                         TUP32150
C                                                                       TUP32160
  100 IF ((IJD .GT. 0) .AND. (IJD .LT. 367)) GO TO 200                  TUP32170
      WRITE(IO,1010) IJD                                                TUP32180
      GO TO 990                                                         TUP32190
C                                                                       TUP32200
  200 IF ((IHR .GE. 0) .AND. (IHR .LT. 25)) GO TO 300
      WRITE(IO,1020) IHR                                                TUP32220
      GO TO 990                                                         TUP32230
C                                                                       TUP32240
  300 NYR = IYR - IZPT                                                  TUP32250
      IF (IJD .LE. NDAY(NYR)) GO TO 400                                 TUP32260
      WRITE(IO,1030) IJD,IYR                                            TUP32270
      GO TO 990                                                         TUP32280
C                                                                       TUP32290
C         CONVERT YEAR/JULIAN DAY/HOUR TO COMMON SEQUENTIAL HOUR.       TUP32300
C                                                                       TUP32310
  400 IYDH = ICUM(NYR) + (IJD - 1) * 24 + IHR                           TUP32320
      GO TO 999                                                         TUP32330
C                                                                       TUP32340
C         ERROR PROCESSING.                                             TUP32350
C                                                                       TUP32360
  990 IYDH = -999999                                                    TUP32370
C                                                                       TUP32380
  999 RETURN                                                            TUP32390
C                                                                       TUP32400
C         FORMAT STATEMENTS.                                            TUP32410
C                                                                       TUP32420
 1000 FORMAT('0*** YEAR INPUT (',I4,') IS NOT WITHIN RANGE OF 60-99.')  TUP32430
 1010 FORMAT('0*** JULIAN DAY INPUT (',I4,') IS NOT WITHIN RANGE OF ',  TUP32440
     1        '1-366.')                                                 TUP32450
 1020 FORMAT('0*** HOUR INPUT (',I4,') IS NOT WITHIN RANGE OF 1-24.')   TUP32460
 1030 FORMAT('0*** JULIAN DAY INPUT (',I4,') CANNOT BE USED FOR YEAR ', TUP32470
     2        I2,'; THIS IS NOT A LEAP YEAR.')                          TUP32480
      END                                                               TUP32490
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C                       INMET (VERSION 86163)
C                       A UTILITY PROCESSOR FOR TUPOS IN                    TPI00020
C                       SECTION 2. NON-GUIDELINE MODELS,                    TPI00030
C                       IN UNAMAP (VERSION 6) JUL 86.                       TPI00040
C                       SOURCE: UNAMAP FILE ON EPA'S UNIVAC 1110, RTP, NC.TPI00050
C                                                                           TPI00060
C          CREATE MET FILE.                                                 TPI00070
      PARAMETER (NLMAX = 20, NDMAX = 40)                                    TPI00080
      DIMENSION ZL(NLMAX),TL(NLMAX),WDL(NLMAX),UL(NLMAX),SAL(NLMAX),        TPI00090
     1 SEL(NLMAX),DTHDZ(NLMAX)                                              TPI00100
      DIMENSION METNAM(2),DESC(18,NDMAX)                                    TPI00110
      WRITE (6,1234)                                                        TPI00120
 1234 FORMAT ('1',21X,'INMET (VERSION 86163)'/
     1 22X,'A UTILITY PROCESSOR FOR TUPOS IN'/                              TPI00140
     2 22X,'SECTION 2. NON-GUIDELINE MODELS,'/                              TPI00150
     3 22X,'IN UNAMAP (VERSION 6) JUL 86.'/                                 TPI00160
     4 22X,'SOURCE: UNAMAP FILE ON EPA''S UNIVAC 1110, RTP, NC.')           TPI00170
C         FIRST DATA LINE                                                   TPI00180
C         METNAM(2)  AN 8 CHARACTER ALPHANUMERIC IDENTIFIER FOR THE MET     TPI00190
C                     DATA.                                                 TPI00200
C         MDATA      DATE-TIME OF DATA CREATION, MO DAY YR (6 DIGITS)       TPI00210
C         MDATB      DATE-TIME OF DATA CREATION, HR MIN SEC (6 DIGITS)      TPI00220
C         ND         NUMBER OF 72 CHARACTER ALPHANUMERIC LINES OF           TPI00230
C                     DESCRIPTION.                                          TPI00240
      READ (5,1000) METNAM,MDATA,MDATB,ND                                   TPI00250
 1000 FORMAT (2A4,2I6,I3)                                                   TPI00260
      DO 10 J = 1,ND                                                        TPI00270
C         NEXT "ND" LINES.                                                  TPI00280
C          DESC  DESCRIPTION OF MET DATA.                                   TPI00290
   10 READ (5,1010) (DESC(I,J), I = 1,18)                                   TPI00300
 1010 FORMAT (18A4)                                                         TPI00310
C         THE ABOVE INPUTS COMPLETES THE HEADER INFO.                       TPI00320
      WRITE (9) METNAM,MDATA,MDATB,ND,                                      TPI00330
     1 ((DESC(I,J), I = 1,18), J = 1,ND)                                    TPI00340
      NREC = 0                                                              TPI00350
C         DATA TYPE 3                                                       TPI00360
C         MYR        YEAR (2 DIGITS)                                        TPI00370
C         MJD        JULIAN DAY (3 DIGITS)                                  TPI00380
C         MHR        HOUR (2 DIGITS)                                        TPI00390
C         NLLIM      NUMBER OF DATA LEVELS THIS HOUR                        TPI00400
C         LMX        THE DATA LEVEL NUMBER OF THE MIXING HEIGHT             TPI00410
C         KLASS      THE STABILITY CATEGORY FOR THIS HOUR                   TPI00420
   20 IRD = 20
      READ (5,1020,ERR=500,END=600) MYR,MJD,MHR,NLLIM,LMX,KLASS             TPI00430
 1020 FORMAT ()                                                             TPI00440
C         DATA TYPE 3 (CONTINUED)
C         MSURE      SEVERE WEATHER CODE
C         MSNOW      SNOW AMOUNT
C         MPPT       PRECIPITABLE (LIQUID) AMOUNT
C         MOBST      OBSTRUCTIONS TO VISIBILITY
C         MVIS       HORIZONTAL SURFACE VISIBILITY
C         MCLD       CLOUD AMOUNT
C         STPRES     STATION PRESSURE (MB)
C         SUNANG     SUN ANGLE WITH RESPECT TO HORIZON
C         USTAR      FRICTION VELOCITY (M/S)
C         HSF        SURFACE HEAT FLUX (W/M**2)
C         OBK        MONIN-OBUKHOV LENGTH (M)
      IRD = 25
      READ (5,1020,ERR=500,END=600) MSURE,MSNOW,MPPT,MOBST,MVIS,
     1 MCLD,STPRES,SUNANG,USTAR,HSF,OBK
      IRD = 30
      DO 30 L = 1,NLLIM                                                     TPI00450
C         DATA TYPE 4 ("NLLIM" OF THESE)                                    TPI00460
C         ZL         HEIGHT OF EACH LEVEL (METERS ABOVE GROUND)             TPI00470
C         TL         TEMPERATURE (K) FOR EACH LEVEL                         TPI00480
C         WDL        WIND DIRECTION (DEGREES AZIMUTH, CLOCKWISE FROM        TPI00490
C                     NORTH) FOR EACH LEVEL                                 TPI00500
C         UL         WIND SPEED (M/SEC) FOR EACH LEVEL                      TPI00510
C         SAL        SIGMA-A STANDARD DEVIATION OF WIND AZIMUTH             TPI00520
C                     (RADIANS) FOR EACH LEVEL                              TPI00530
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C         SEL          SIGMA-E STANDARD DEVIATION OF WIND ELEVATION ANGLE  TPI00540
C                       (RADIANS) FOR EACH LEVEL                          TPI00550
C          DTHDZ        D THETA/DZ FOR THE LAYER WHOSE BASE               TPI00560
C                        IS AT THIS LEVEL.                                TPI00570
C              DTHDZ SHOULD BE ENTERED AS ZERO IF YOU GAVE AN             TPI00580
C               ENTRY FOR TEMPERATURE, TL.                                TPI00590
C              CAN OPTIONALLY INPUT ZERO FOR TL FOR SECOND AND            TPI00600
C               SUBSEQUENT LAYERS.  THIS WILL HAVE THE EFFECT             TPI00610
C               OF CALCULATING THE TEMPERATURE FOR THAT HEIGHT            TPI00620
C               FROM THE FURNISHED D THETA/DZ FOR THE LAYER               TPI00630
C               WHOSE TOP IS AT THIS HEIGHT.                              TPI00640
      READ (5,1020,ERR=500,END=600) ZL(L),TL(L),WDL(L),UL(L),SAL(L),      TPI00650
     1 SEL(L),DTHDZ(L)                                                    TPI00660
      IF (TL(L).EQ.0.) TL(L) = (DTHDZ(L-1) - 0.0098) * (ZL(L) - ZL(L-1))TPI00670
     1 + TL(L-1)                                                          TPI00680
   30 CONTINUE                                                            TPI00690
      WRITE (9) MYR,MJD,MHR,NLLIM,LMX,KLASS, MSURE,MSNOW,MPPT,MOBST,
     1 MVIS,MCLD,STPRES,SUNANG,USTAR,HSF,OBK,
     2 (ZL(I),TL(I),WDL(I),UL(I),SAL(I),SEL(I), I = 1,NLLIM)
      NREC = NREC + 1                                                     TPI00720
      GO TO 20                                                            TPI00730
  500 WRITE (6,1110) IRD,NREC
 1110 FORMAT ('0SYSTEM ERROR ON READING MET DATA RECORD!   IRD=',
     1 I2,'    NREC=',I3)
      STOP                                                                TPI00760
  600 WRITE (6,1030) NREC                                                 TPI00770
 1030 FORMAT ('0NORMAL TERMINATION.',I4,' HOURLY RECORDS WRITTEN TO FILETPI00780
     1 9.')                                                               TPI00790
      STOP                                                                TPI00800
      END                                                                 TPI00810
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C                    LSTMET (VERSION 86164)
C                    A UTILITY PROCESSOR FOR TUPOS IN                    TPL00020
C                    SECTION 2. NON-GUIDELINE MODELS,                    TPL00030
C                    IN UNAMAP (VERSION 6) JUL 86.                       TPL00040
C                    SOURCE: UNAMAP FILE ON EPA'S UNIVAC 1110, RTP, NC.TPL00050
C          PROGRAM LSTMET.                                               TPL00060
C           LIST MET DATA FOR SELECTED HOURS.                            TPL00070
C                                                                        TPL00080
      PARAMETER (NLMAX = 20, NDMAX = 40)                                 TPL00090
      DIMENSION ZL(NLMAX),TL(NLMAX),WDL(NLMAX),UL(NLMAX),SAL(NLMAX),     TPL00100
     1 SEL(NLMAX),DTHDZ(NLMAX),ALP(NLMAX)                                TPL00110
      DIMENSION MID(2),METNAM(2),DESC(18,NDMAX)                          TPL00120
      DATA ICON /0/, BLNK /' '/, ASTR /'*'/                              TPL00130
      WRITE (6,1234)                                                     TPL00140
 1234 FORMAT ('1',21X,'LSTMET (VERSION 86164)'/                          TPL00150
     1 22X,'A UTILITY PROCESSOR FOR TUPOS IN'/                           TPL00160
     2 22X,'SECTION 2. NON-GUIDELINE MODELS,'/                           TPL00170
     3 22X,'IN UNAMAP (VERSION 6) JUL 86.'/                              TPL00180
     4 22X,'SOURCE: UNAMAP FILE ON EPA''S UNIVAC 1110, RTP, NC.')        TPL00190
C         FIRST DATA LINE                                                TPL00200
C          DATA LABELS TO COMPARE WITH METEOROLOGICAL FILE.              TPL00210
C          MID  8-CHARACTER IDENTIFIER                                   TPL00220
C          MA   6-DIGIT DATE-TIME ID                                     TPL00230
C          MB   6-DIGIT TIME ID                                          TPL00240
      READ (5,1000)MID,MA,MB                                             TPL00250
 1000 FORMAT (2A4,2I6)                                                   TPL00260
      READ (9) METNAM,MDATA,MDATB,ND,                                    TPL00270
     1 ((DESC(I,J), I = 1,18), J = 1,ND)                                 TPL00280
      IF (MID(1).EQ.METNAM(1)) GO TO 10                                  TPL00290
      ICON = 1                                                           TPL00300
   10 IF (MID(2).EQ.METNAM(2)) GO TO 20                                  TPL00310
      ICON = 1                                                           TPL00320
   20 IF (MA.EQ.MDATA) GO TO 30                                          TPL00330
      ICON = 1                                                           TPL00340
   30 IF (MB.EQ.MDATB) GO TO 40                                          TPL00350
      ICON = 1                                                           TPL00360
   40 IF (ICON.EQ.0) GO TO 50                                            TPL00370
      WRITE (6,1010) METNAM,MDATA,MDATB,MID,MA,MB                        TPL00380
 1010 FORMAT ('0MET DATA FILE IS LABELLED:',2A4,',',I8,',',I8,           TPL00390
     1 ';  EXPECTED:',2A4,',',I8,',',I8,'.')                             TPL00400
      STOP                                                               TPL00410
C         LIST HEADER AND DESCRIPTION.                                   TPL00420
   50 WRITE(6,1020) METNAM,MDATA,MDATB                                   TPL00430
      WRITE(6,1030) (DESC(J,1), J = 1,18)                                TPL00440
      IF (ND .EQ. 1) GO TO 120                                           TPL00450
      DO 110 N = 2,ND                                                    TPL00460
         WRITE(6,1040) (DESC(J,N), J = 1,18)                             TPL00470
  110 CONTINUE                                                           TPL00480
  120 CONTINUE                                                           TPL00490
 1020 FORMAT('0MET FILE IDENTIFIER:  ',2A4,/,                            TPL00500
     1        1X,'CREATED:  ',I6,' (YR MO DAY)',5X,I6,' (HR MIN SEC)')  TPL00510
 1030 FORMAT(1X,'DESCRIPTION:  ',18A4)                                   TPL00520
 1040 FORMAT(1X,14X,18A4)                                                TPL00530
C         SECOND (AND SUBSEQUENT ) DATA LINE.                            TPL00540
C           IYR  START PRINT - 2 DIGIT YEAR                              TPL00550
C           IJD  START PRINT - JULIAN DAY                                TPL00560
C           IHR  START PRINT - HOUR (1-24)                               TPL00570
C           JYR  END PRINT - 2 DIGIT YEAR                                TPL00580
C           JJD  END PRINT - JULIAN DAY                                  TPL00590
C           JHR  END PRINT - HOUR (1-24)                                 TPL00600
   70 READ (5,1050,END=700) IYR,IJD,IHR,JYR,JJD,JHR                      TPL00610
C         END OF FILE ENTRY FOR THE ABOVE LINE CAUSES                    TPL00620
C          NORMAL TERMINATION.                                           TPL00630
 1050 FORMAT ()                                                          TPL00640
      WRITE (6,1060) IYR,IJD,IHR,JYR,JJD,JHR                             TPL00650
 1060 FORMAT ('0LIST MET DATA FROM:',I3,'/',I3,'/',I2,                   TPL00660
     1 '      TO:',I3,'/',I3,'/',I2)                                     TPL00670
      CALL CHRON (IYR,IJD,IHR,IYDH)                                      TPL00680
      CALL CHRON (JYR,JJD,JHR,JYDH)                                      TPL00690
  100 READ (9,ERR=500,END=600) MYR,MJD,MHR,NLLIM,LMX,KLASS,
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     1 MSURE,MSNOW,MPPT,MOBST,MVIS,MCLD,STPRES,SUNANG,USTAR,HSF,OBK,
     2 (ZL(I),TL(I),WDL(I),UL(I),SAL(I),SEL(I), I = 1,NLLIM)
      CALL CHRON (MYR,MJD,MHR,MYDH)
      IF (MYDH.LT.IYDH) GO TO 100
      IF (MYDH.GT.JYDH) GO TO 70
C
C        LIST MET DATA.
C
      LIM = NLLIM - 1
      DO 200 L = 1,LIM
      LT = L + 1
C        CALCULATE D THETA/DZ BETWEEN LAYERS FOR
C         INCLUSION ON PRINT OUT.
      DTHDZ(L) = (TL(LT) - TL(L))/(ZL(LT) - ZL(L)) + 0.0098
  200 IF (TL(LT).EQ.-9999..OR.TL(L).EQ.-9999.) DTHDZ(L) = -9999.9999
      DO 250 L = 1,NLLIM
      ALP(L) = BLNK
      IF (L.EQ.LMX) ALP(L) = ASTR
  250 CONTINUE
      WRITE (6,1090) MYR,MJD,MHR,LMX,KLASS
 1090 FORMAT ('0MET DATA FOR YEAR:',I3,'  JUL DAY:',I4,'  HOUR:',
     1 I3,'  LMX =',I2,'  KLASS =',I2)
      WRITE (6,1210)
 1210 FORMAT (' SURESNOWPPTOBST VIS CLD  STPRES   SUNANG   USTAR ',
     1 '       HSF              OBK')
      WRITE (6,1220) MSURE,MSNOW,MPPT,MOBST,MVIS,MCLD,STPRES,SUNANG,
     1 USTAR,HSF,OBK
 1220 FORMAT (6I4,2F9.2,F8.4,2F15.4)
      WRITE (6,1230)
 1230 FORMAT (' LVL     HT   MIX          ',
     2 'SA          SE        WD          U          T          DTHDZ')
      WRITE (6,1100) NLLIM,ZL(NLLIM),ALP(NLLIM),SAL(NLLIM),SEL(NLLIM),
     1 WDL(NLLIM), UL(NLLIM),TL(NLLIM)
      DO 300 L = 1,LIM
      LT = NLLIM - L
  300 WRITE (6,1100) LT,ZL(LT),ALP(LT),SAL(LT),SEL(LT),WDL(LT),UL(LT),
     1 TL(LT),DTHDZ(LT)
 1100 FORMAT (I3,F10.1,2X,A1,2X,2F10.4,F10.1,2F10.2,F10.4)
      IF (MYDH.EQ.JYDH) GO TO 70
      GO TO 100
  500 WRITE (6,1110)
 1110 FORMAT ('0SYSTEM ERROR ON READING MET DATA RECORD!')
      STOP
  600 WRITE (6,1120)
 1120 FORMAT ('0MET FILE WAS EHAUSTED WITHOUT FINDING DATA FOR THE HOUR
     1REQUESTED!')
      STOP
  700 WRITE (6,1130)
 1130 FORMAT ('0 NORMAL TERMINATION')
      STOP
      END
C
      SUBROUTINE CHRON(IYR,IJD,IHR,IYDH)
C        CHRON-CONVERT-DATE
C
C        ARGUMENT LIST:
C          INPUT:   IYR  - YEAR (2 DIGITS)
C                   IJD  - JULIAN DAY (3 DIGITS)
C                   IHR  - HOUR (2 DIGITS)
C          OUTPUT:  IYDH - DATE CONVERTED TO HOUR
C
C        CALLING ROUTINES:
C          TU220, TU320, TU325
C
C        DESCRIPTION:
C          THIS SUBROUTINE CONVERTS DATES BETWEEN 1960 AND 1999 TO A
C          COMMON SEQUENTIAL HOUR.  THE ZERO POINT IS 1959, 365, 24,
C          I.E., HOUR 1 IS THE FIRST HOUR OF 1960.
C
      DIMENSION ICUM(41),NDAY(40)
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      DATA IO/6/                                                        TPL01310
      DATA ICUM/      0,  8784, 17544, 26304, 35064, 43848, 52608,      TPL01320
     1          61368, 70128, 78912, 87672, 96432,105192,113976,       TPL01330
     2         122736,131496,140256,149040,157800,166560,175320,       TPL01340
     3         184104,192864,201624,210384,219168,227928,236688,       TPL01350
     4         245448,254232,262992,271752,280512,289296,298056,       TPL01360
     5         306816,315576,324360,333120,341880,350640/              TPL01370
      DATA NDAY/366,365,365,365,                                        TPL01380
     1          366,365,365,365,                                        TPL01390
     2          366,365,365,365,                                        TPL01400
     3          366,365,365,365,                                        TPL01410
     4          366,365,365,365,                                        TPL01420
     5          366,365,365,365,                                        TPL01430
     6          366,365,365,365,                                        TPL01440
     7          366,365,365,365,                                        TPL01450
     8          366,365,365,365,                                        TPL01460
     9          366,365,365,365/                                        TPL01470
      DATA IZPT/59/                                                     TPL01480
C                                                                       TPL01490
C         SCREEN INPUT.                                                 TPL01500
C                                                                       TPL01510
      IF ((IYR .GT. 59) .AND. (IYR .LT. 100)) GO TO 100                 TPL01520
      WRITE(IO,1000) IYR                                                TPL01530
      GO TO 990                                                         TPL01540
C                                                                       TPL01550
  100 IF ((IJD .GT. 0) .AND. (IJD .LT. 367)) GO TO 200                  TPL01560
      WRITE(IO,1010) IJD                                                TPL01570
      GO TO 990                                                         TPL01580
C                                                                       TPL01590
  200 IF ((IHR .GE. 0) .AND. (IHR .LT. 25)) GO TO 300
      WRITE(IO,1020) IHR                                                TPL01610
      GO TO 990                                                         TPL01620
C                                                                       TPL01630
  300 NYR = IYR - IZPT                                                  TPL01640
      IF (IJD .LE. NDAY(NYR)) GO TO 400                                 TPL01650
      WRITE(IO,1030) IJD,IYR                                            TPL01660
      GO TO 990                                                         TPL01670
C                                                                       TPL01680
C         CONVERT YEAR/JULIAN DAY/HOUR TO COMMON SEQUENTIAL HOUR.       TPL01690
C                                                                       TPL01700
  400 IYDH = ICUM(NYR) + (IJD - 1) * 24 + IHR                           TPL01710
      GO TO 999                                                         TPL01720
C                                                                       TPL01730
C         ERROR PROCESSING.                                             TPL01740
C                                                                       TPL01750
  990 IYDH = -999999                                                    TPL01760
C                                                                       TPL01770
  999 RETURN                                                            TPL01780
C                                                                       TPL01790
C         FORMAT STATEMENTS.                                            TPL01800
C                                                                       TPL01810
 1000 FORMAT('0*** YEAR INPUT (',I4,') IS NOT WITHIN RANGE OF 60-99.')  TPL01820
 1010 FORMAT('0*** JULIAN DAY INPUT (',I4,') IS NOT WITHIN RANGE OF ',  TPL01830
     1       '1-366.')                                                  TPL01840
 1020 FORMAT('0*** HOUR INPUT (',I4,') IS NOT WITHIN RANGE OF 1-24.')   TPL01850
 1030 FORMAT('0*** JULIAN DAY INPUT (',I4,') CANNOT BE USED FOR YEAR ', TPL01860
     2       I2,'; THIS IS NOT A LEAP YEAR.')                           TPL01870
      END                                                               TPL01880
```